Iron AND Steel ENGINEER

ENGINEERING SERVICE
TO THE IRON AND STEEL
INDUSTRY SINCE 1907

TECHNOLOGY DEPT:
1010 EMPIRE BUILDING

NOVEMBER, 1942

PITTSBURGH, PA.

Equip your steel mill machines for Victory—and whatever may follow. Install Timken Bearings throughout. Redesign now.

This Bonnot 36"-48" Hydrofeed Cold Saw represents a tremendous advance in cutting sections of steel billets and bars for photomicrographic inspection.

It is considerably faster in operation and produces smoother, much more uniform sections that do not take as much time to prepare.

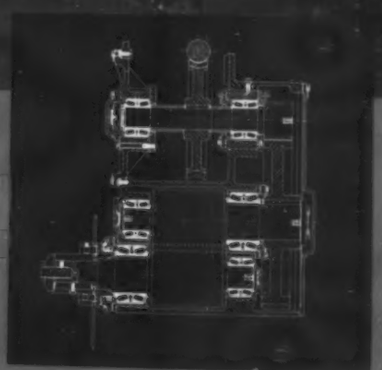
The saw was designed and manufactured by The Bonnot Company, Canton, Ohio, in collaboration with the engineering department of the Steel & Tube Division of The Timken Roller Bearing Company and has proved eminently satisfactory in service. It is electrically driven and has full automatic hydraulic feed.

To assure smoothness, accuracy and endurance plus low operating and maintenance costs, the saw arbor and drive shafts are mounted on double-row Timken Bearings. The pinion shaft is mounted on single-row Timkens.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Bonnot 36"-48" Hydrofeed Cold Saw shown in operation in the Timken Steel Plant.



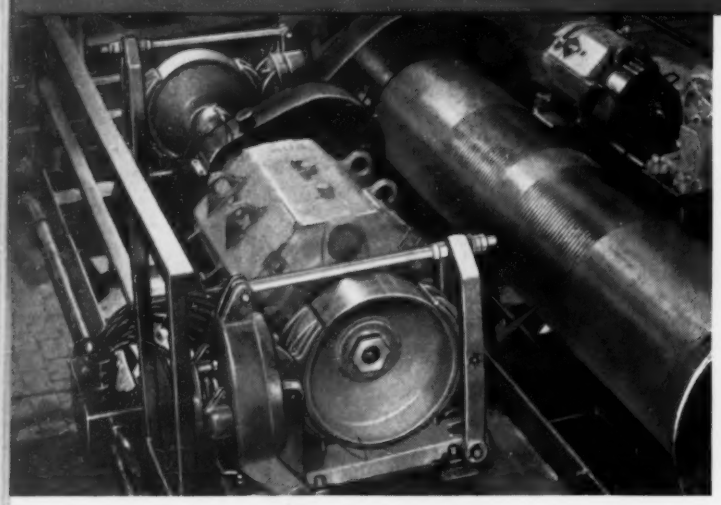
Application of Timken Bearings in the Bonnot Hydrofeed Cold Saw.

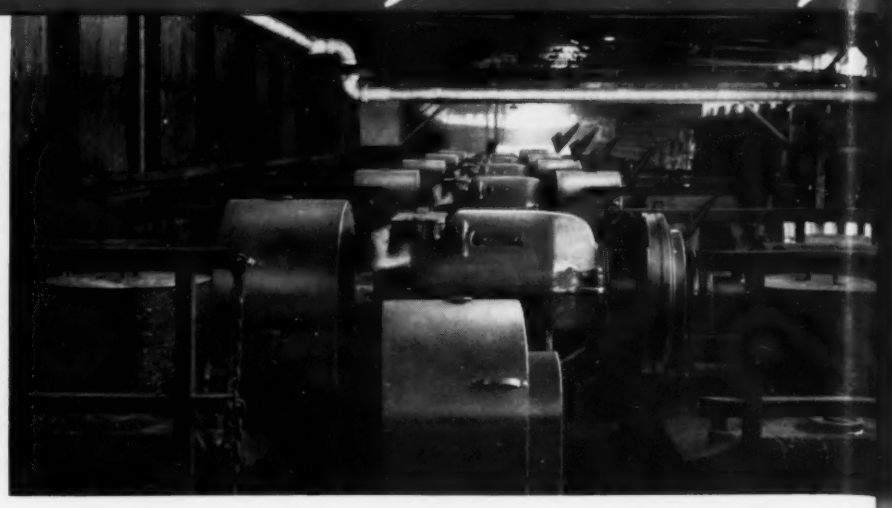
HELP ASSURE VICTORY

Buy War Bonds. Conserve Rubber. Eliminate Unnecessary Travel. Use the Telephone Only When Important. Salvage All Scrap and Waste Material.

For Speed and Efficiency

LIFT, TURN, STOP, SORT *Magnetically*



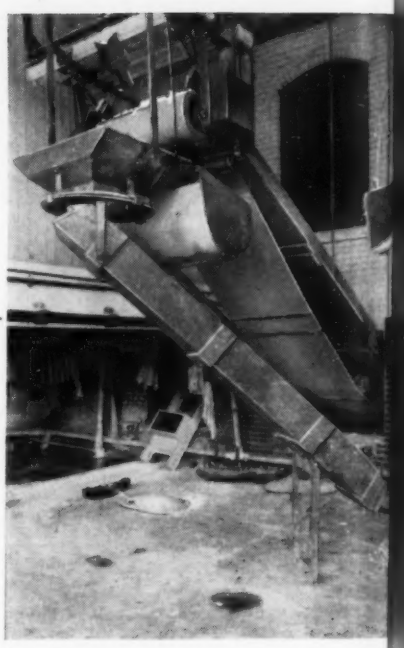


Stops them "dead"

Where machines must be stopped—quickly and without shock, jar, or damage, use a Cutler-Hammer Magnetic Brake . . . controlled by a push button or any automatic contact arrangement. Action smoothly cushioned magnetically, operation is positive and assured. For hoists and cranes in steel mills, and marine service—in fact wherever loads are to be "held" or machines "stopped." Ask a Cutler-Hammer Engineer.

Smooth and automatic starts

To start and stop machines smoothly, automatically, investigate C-H Magnetic Clutches. All mechanical clutch functions, many *extra* advantages. Remote control by simple relay and push button. Provides automatic machine operation where space is at a premium, or speed relationship is fixed. Wide range of sizes.



Mountains of Iron and Steel Moved Fast

Whether you want the world's largest lifting magnet, a hold-down magnet, a slab-turning magnet or a tiny 5 inch hand magnet, you get maximum metal handling and use from a C-H *Supermagnet*: handle scrap, rolled strip steel, hot castings, gun barrels, tubes, bagged or boxed parts, etc. Ask a Cutler-Hammer Engineer.

Protection that never sleeps

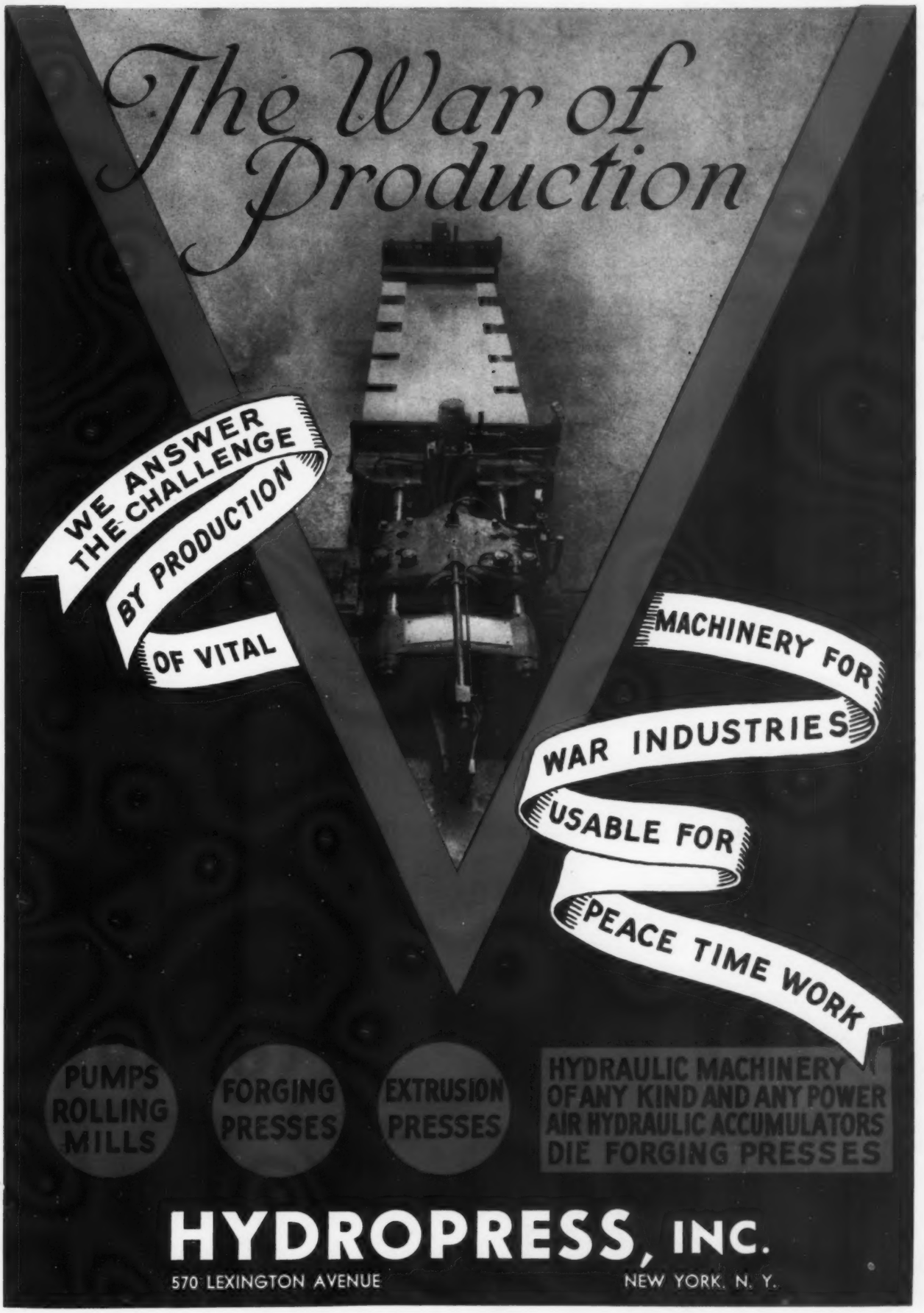
Cutler-Hammer Magnetic Separators remove stray pieces of iron and steel from valuable raw materials in many manufacturing processes, and prevent contamination of chemicals, foodstuffs or many other substances in process. A valuable ally in salvaging scrap iron from slag dumps, garbage, etc. Always on the job, protecting your machines from damage and demoralized production. If stray iron is a problem in your plant, let a Cutler-Hammer Engineer help you out.

Electro-Magnetism obeys your commands instantly and is the easiest of all energy to control. So put this speedy and obedient servant to work increasing production for you...smoothly clutching and declutching giant machines, starting and stopping parts of machines in automatic cycles, making molehills out of mountains of steel and iron, or protecting valuable materials against stray bits of scrap iron. Cutler-Hammer Magnetic Clutches, Brakes, Separators and Lifting Magnets are the product of a half century of specialization and their dependability is world famous. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

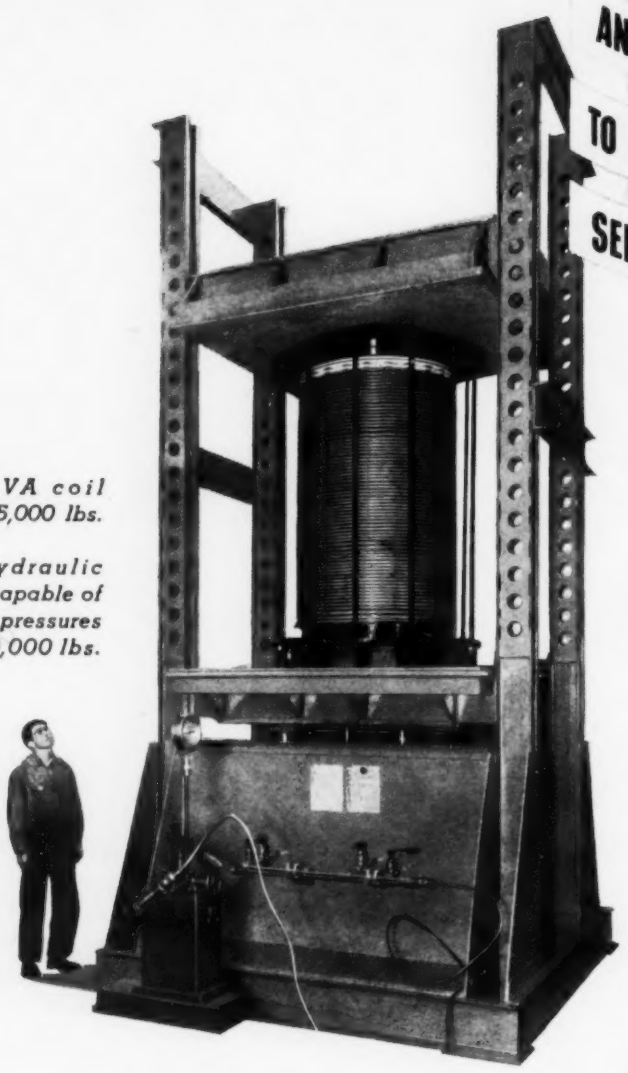
Made by the makers of

CUTLER-HAMMER
MOTOR CONTROL
C-H

1892-1942 50th Anniversary


The War of Production
WE ANSWER THE CHALLENGE
BY PRODUCTION
OF VITAL
MACHINERY FOR
WAR INDUSTRIES
USABLE FOR
PEACE TIME WORK
PUMPS
ROLLING
MILLS
FORGING
PRESSES
EXTRUSION
PRESSES
HYDRAULIC MACHINERY
OF ANY KIND AND ANY POWER
AIR HYDRAULIC ACCUMULATORS
DIE FORGING PRESSES
HYDROPRESS, INC.
570 LEXINGTON AVENUE
NEW YORK, N. Y.

ANOTHER *Pennsylvania* INNOVATION
TO INSURE UNFAILING TRANSFORMER
SERVICE FOR WAR INDUSTRIES . . .



5000 KVA coil under 125,000 lbs. pressure.
This Hydraulic press is capable of exerting pressures up to 600,000 lbs.

The fundamental principles of building transformers to withstand short circuits are as follows:

1. The coils and all insulation must be dried sufficiently to make sure that no shrinkage will take place when the transformer is in operation or is under a short circuit.
2. The dry coils must be pre-compressed to such an extent that no further compression can take place under the most severe short circuit. This definitely precludes any possibility of the coil stack moving or distorting under short circuit.
3. After drying and pre-compressing, the coils must be treated in such a manner that they are self-supporting and will maintain their pre-compressed and pre-shrunk shape when mounted on the core.
4. The final step is to provide sufficiently strong supports at the top and bottom of the group of coils to keep the coils in their pre-compressed shape.

Every Pennsylvania Transformer of the Helical and Pancake type is constructed on these principles.

A Sure Way of Building Transformers

THE ability of the coil to maintain its shape under the prescribed pressure is your guarantee that the transformer will withstand short circuits.

Pennsylvania TRANSFORMERS

Pennsylvania
TRANSFORMER COMPANY 808 RIDGE AVENUE • N. S., PITTSBURGH, PA.

The WEAN ENGINEERING COMPANY, Inc. • WARREN, OHIO

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

ARMOR PLATE LEVELLERS

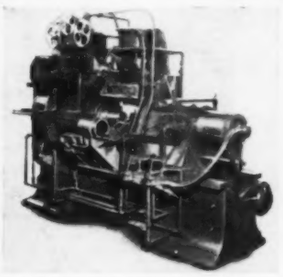
HI-SPEED SHEET AND TIN MILL SHEAR LINES

ELECTROLYTIC & BONDERIZING TIN PLATE EQUIPMENT

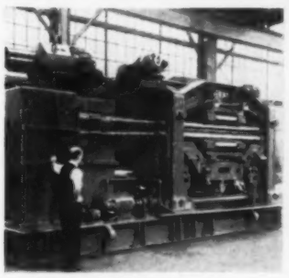
WILSON TUBE ANNEALING FURNACES

WEAN VACUUM CUP SHEET AND PLATE LIFTERS

CONTINUOUS STRIP PICKLING, SLITTING, SIDE TRIMMING, AND RECOILING LINES

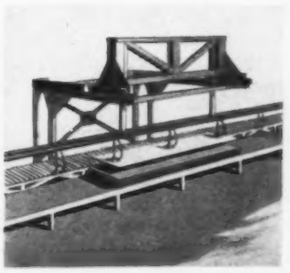


Shell and Sleeve Lathe



Armor Plate Leveller

Wilson Tube Type Annealing Furnace



Wean Vacuum Cup Sheet and Plate Lifter

For Victory!

SUBSIDIARY COMPANY: THE BROOKE CONSTRUCTION CO., CLEVELAND, O. • MFRS. OF STRIP AND WIRE MILL MACHINERY

Cleveland Cranes are different from other cranes because all parts are welded including the girders. There is no sag from rivet slippage to cause misalignment and abnormal wear. Because of the special shoulder construction, girders remain square with the end trucks for the life of the crane.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

THE HANDLE WITH CARE sign is important today. It belongs on every tool and on every piece of equipment in America. We can't afford a speck of waste, and even the toughest equipment will last longer when cared for properly.

For example, your sturdy, long-lived, dependable Exide Batteries will last even longer if you follow the simple maintenance steps given on this page. The rule of the day is *Handle With Care.* Treat your batteries right . . . and you help treat the Axis rough.

MAKING BATTERIES LAST HELPS STOP THE AXIS!

1 Keep adding approved water at regular intervals. Most local water is safe. Ask us if yours is safe.

2 Keep the top of the battery and battery container clean and dry at all times. This will assure maximum protection of the inner parts.

3 Keep the battery fully charged—but avoid excessive over-charge. A storage battery will last longer when charged at its proper voltage.

4 Record water additions, voltage, and gravity readings. Don't trust your memory. Write down a complete record of your battery's life history. Compare readings.

If you wish more detailed information, or have a special battery problem, don't hesitate to write to Exide. We want you to get the long-life built into every Exide Battery. Ask for booklet Form 1982.

Exide
IRONCLAD
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

PRODUCTION
Holds the Answer

And we mean both *super* production and *speedy* production. Any method or equipment that can increase tonnage of finished product and save time should be thoroughly investigated. That's the reason we urge every steel plant engineer and executive to become familiar with the

BILLETEER

This mechanized billet chipper will —

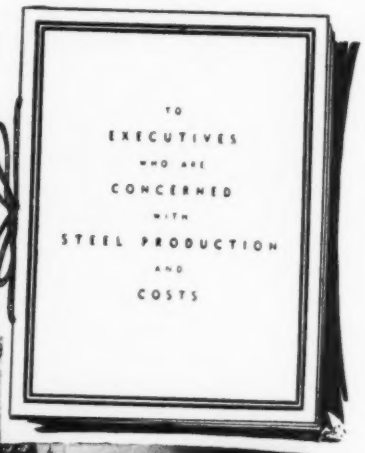
- **Speed up billet chipping as much as 90 per cent.**
- **Average a 50 per cent saving on chipping costs.**
- **Save billets unprofitable to clean by hand.**
- **Work equally well on ANY analysis steel.**
- **Eliminate the "headache" of maintaining an adequate force of hand chippers.**

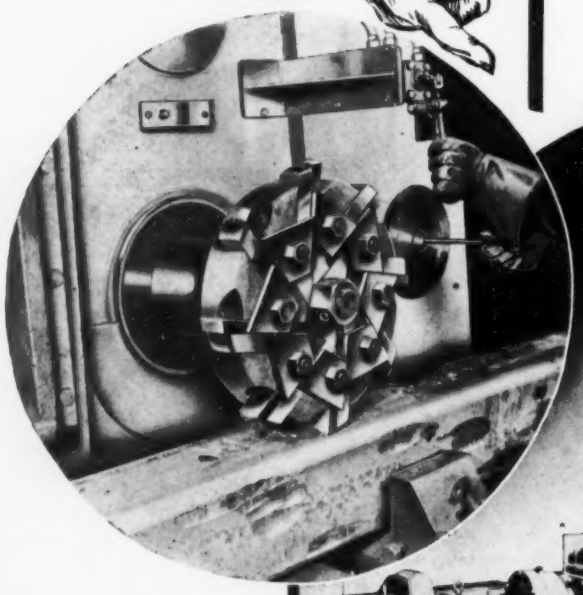
Built for continuous operation, BILLETEERS soon pay back their original cost. You can be sure of a good return on your investment when you put one to work in your production line.

Determine NOW what Billeteers can do for you — discuss your chipping department problems with one of our sales engineers.

SEND FOR THIS BROCHURE

It gives information vital to every steel plant engineer and executive.





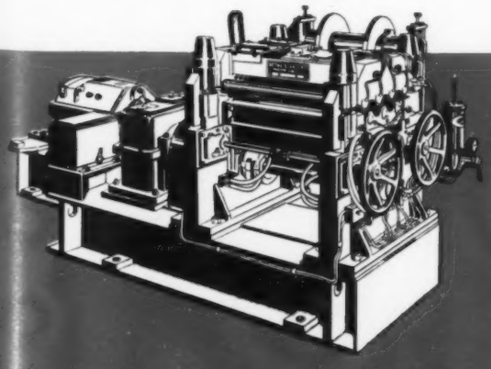
BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO

SYMBOLS of FREEDOM

AUTUMN INTERLUDE

This fall you may have missed the keen enjoyment of being in the fields or woods following an alert and eager dog. Many of you, who loved this sport, are in the service hunting bigger game; others are busy with all-out victory production. This is only a temporary interruption and, when we've finished the job, this typically American institution will again take its place as a symbol of American Freedom.



The Aetna-Standard Pull-Through Strip Breaker will handle strip from two to sixteen inches wide, .040" to .1875" thick at speeds up to one thousand feet per minute.

ARMY E NAVY

The AETNA-STANDARD ENGINEERING COMPANY

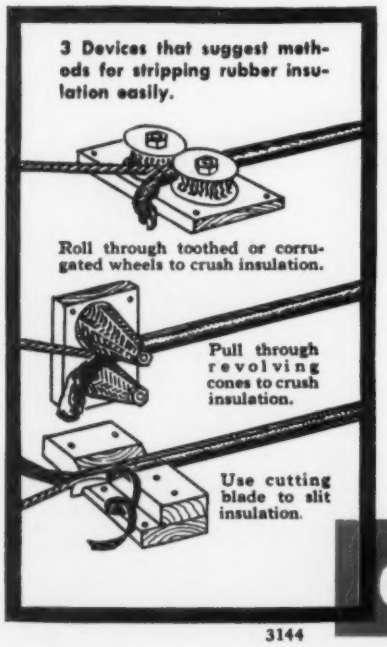
YOUNGSTOWN, OHIO, U.S.A.

ASSOCIATED COMPANIES

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND • JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Designers and Builders to the Steel, Non-ferrous and Chemical Industries

that Rubber Scrap is Priceless!


3 Devices that suggest methods for stripping rubber insulation easily.
Roll through toothed or corrugated wheels to crush insulation.
Pull through revolving cones to crush insulation.
Use cutting blade to slit insulation.

3144

The rubber insulation of wire and cable is even more valuable today than the copper conductor, scarce as copper is! Saving vital copper is absolutely necessary, of course, but the rubber in wire and cable insulation is priceless. The rubber shortage is so acute that immediate corrective measures in both military and civilian life have become necessary. So get into the scrap and salvage both copper *and* rubber.

Okonite cords, cables and insulations have extra years of service built into them. Get these extra years of service by using every precaution for their protection and longevity.* But, if they can no longer be used, *strip* off the rubber insulation and sell it to a licensed rubber dealer and sell the copper conductor to a metal dealer.

The scrap you save here and now may later become the difference between victory and defeat on some far-flung battlefield.

*If you have not already received a copy of the booklet "Do's, Don'ts and How's For Longer Life of Your Insulated Wires and Cables" write for a copy today.

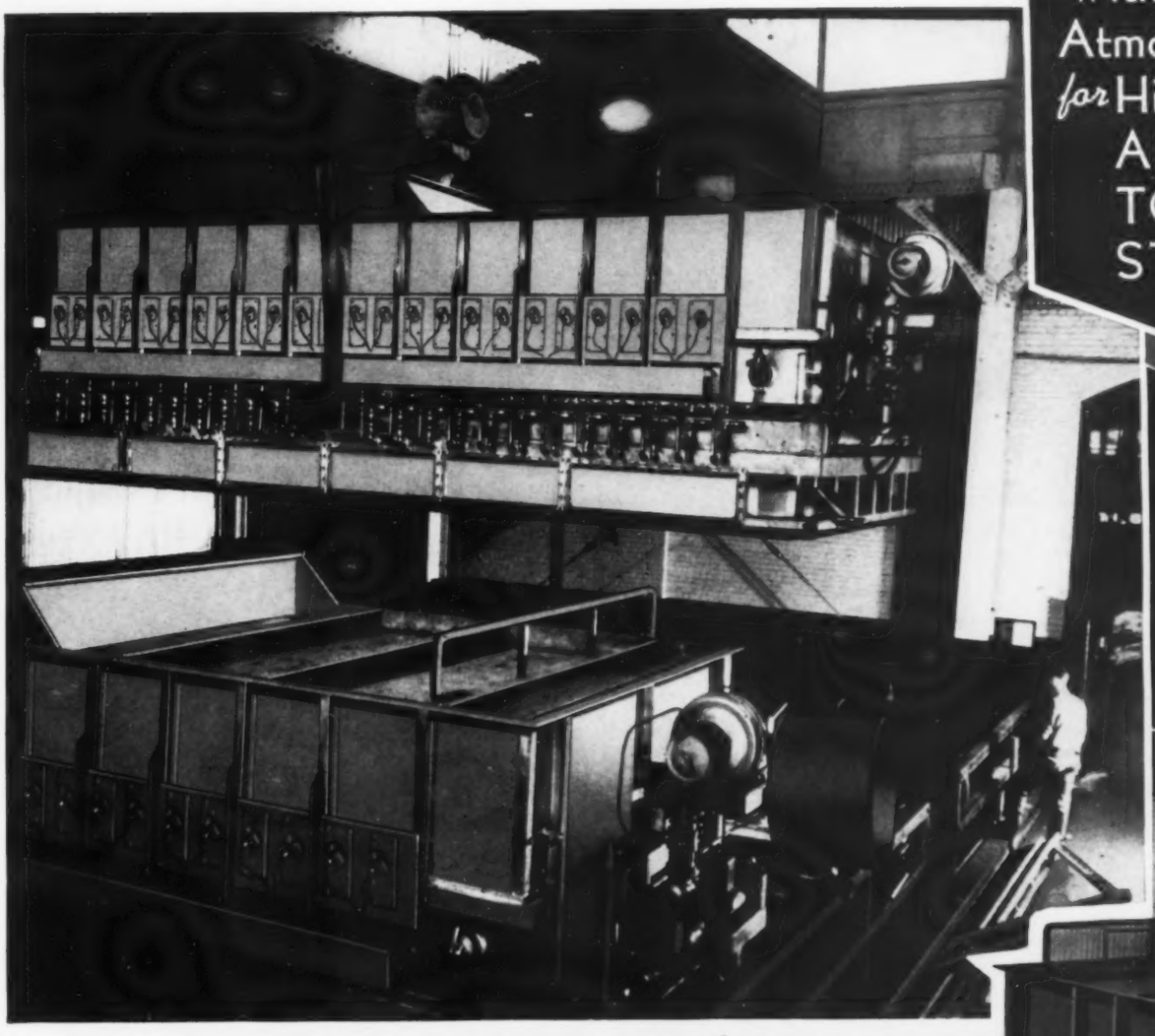
THE OKONITE COMPANY
Passaic, New Jersey Offices in Principal Cities

OKONITE Insulated Wires & Cables

Salvage Your Scrap — Buy U. S. War Bonds

RECTANGULAR BELL TYPE FURNACES *for* *Annealing Treatments of* LONG BARS *and* TUBES COLD DRAWN *or* HOT ROLLED

With Special Atmospheres *for* Hi-Carbon Alloy *and* TOOL STEELS



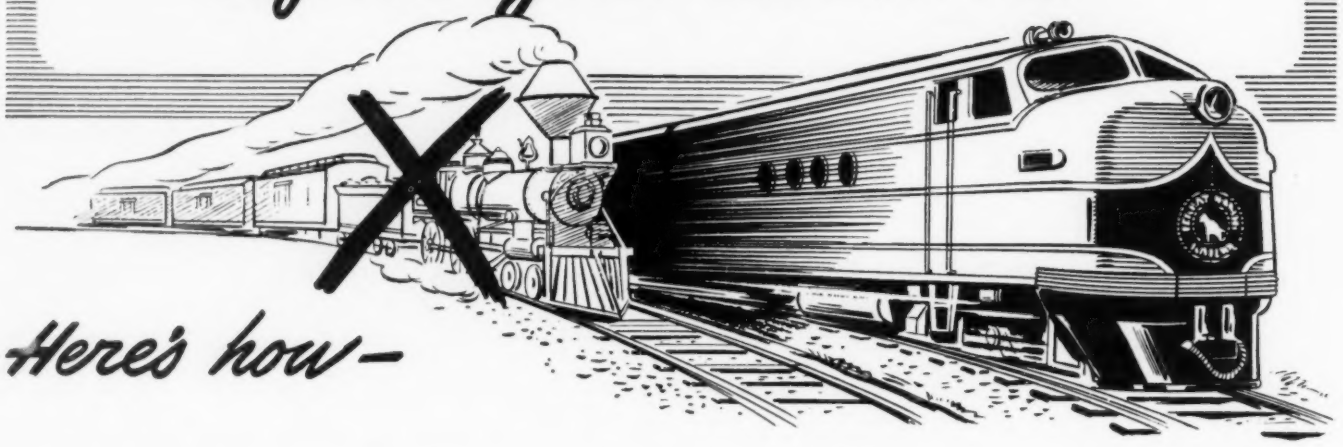
These Furnaces handle BARS 25 ft. Long

Lee Wilson ENGINEERING Co.

20005 West Lake Road CLEVELAND, OHIO

Telephone AC-4670

BAKER TRUCKS can help you to *Speed your deliveries*



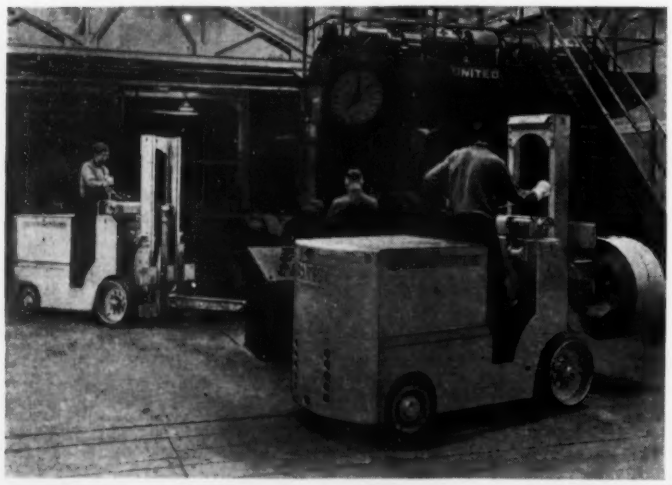
Here's how—

1. FASTER LOADING AND UNLOADING

Many man hours are saved loading and unloading box cars, trucks and trailers with Baker Low Lift and Elevating Trucks. Baker Crane Trucks speed loading and unloading of heavy, bulky materials on flat cars or ships.

2. SPEEDING PLANT PRODUCTION

By keeping materials moving and stepping up efficiency of machines and men, plant production can be increased and delivery dates moved up.



3. SHIPPING AND RECEIVING IN UNIT PACKAGES

The use of skids and pallets with Baker Trucks eliminates individual handling of parts or products —saving time on both shipping and receiving ends.

4. LESS DAMAGE IN HANDLING AND TRANSIT

By reducing piece handling and by better placing of materials in cars or trucks, loss by damage to merchandise is greatly reduced.

5. BETTER WAREHOUSE HANDLING

Baker Trucks speed handling in storage and bring the warehouse many minutes nearer to the loading platform.

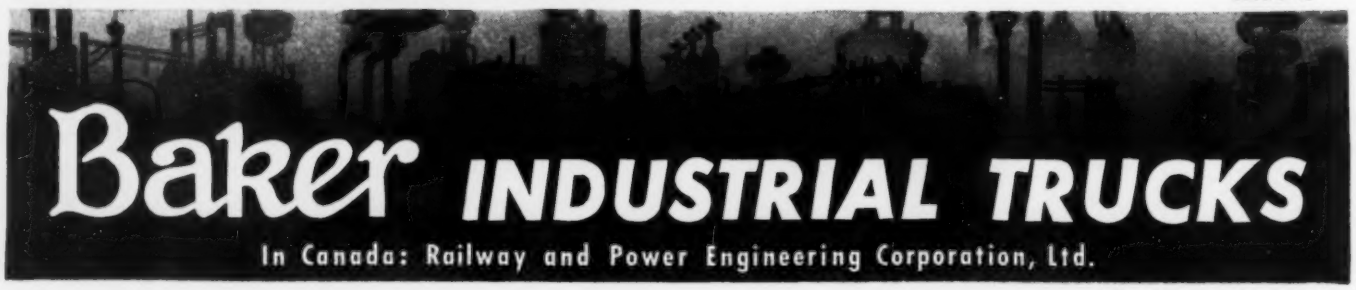
* * *

THE BAKER MATERIAL HANDLING ENGINEER CAN HELP YOU

He knows how to make your material handling more efficient to speed your deliveries. He is at your service.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker Raulang Company
2166 West 25th Street • Cleveland, Ohio

2200-5-42



A. I. S. E. STANDARD CRANE SPECIFICATIONS

1. Explanation:

These specifications cover heavy duty, mill type, overhead traveling cranes. All cranes for [illegible]

Crane Specification. It shall be referred to in all contracts as such and shall form part of such contracts [illegible] ached to same or not. [illegible] known as contractor's [illegible]ns shall take precedence [illegible]s and shall be strictly [illegible]fications or understand- [illegible]greed to in writing.

[illegible]ser stating sizes, special [illegible]all be known as "pur- [illegible]Where the requirements [illegible]r from specification, the

[illegible]er showing specific data [illegible]oses to furnish, shall be [illegible] contractor's information sheets."

Where contract covers a number of cranes, this specification shall apply to each and every one.

In addition to specifications furnished with proposition, contractor shall furnish the required number of copies of his specifications for the purchaser's file.

[illegible] sary after contract is signed.

[illegible] either on the [illegible]ley motor shaft [illegible]tly on the periphery of one of the trolley track wheels.

38. Brakes:

BRIDGE BRAKES:

1. Each bridge drive shall be equipped with hydraulic brake or brakes, of sufficient size to stop crane within a distance in feet equal to ten per cent of full load speed in feet per minute, when traveling at full speed with full load. The size of brake furnished shall be the responsibility of the contractor.

2. The stroke of the bridge brake foot pedal shall not be more than 8 in. and lever shall be so designed that it will not interfere with necessary movements of operator's legs or feet while operating the crane.

3. In addition to the hydraulic brakes, all cranes with anti-friction bearings on the bridge drive designed for more than 300 fpm bri[illegible] with dynamic brakin[illegible]rovided

4. If specifi[illegible] provided wit[illegible] drive, so a[illegible] disconne[illegible] opened[illegible]

5[illegible] the s[illegible]

m[illegible]

WAGNER HYDRAULIC BRIDGE BRAKING SYSTEMS MEET ALL A. I. S. E. SPECIFICATIONS!

★ ★ ★ ★ ★ ★ ★

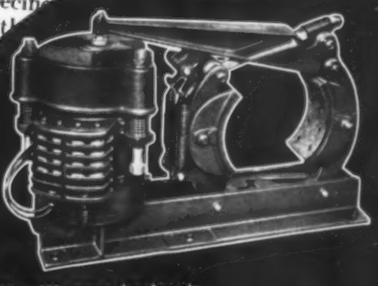
In addition to meeting all of the requirements of the Association of Iron and Steel Engineers, Wagner Hydraulic Bridge Braking Systems have features that make them the choice of most of the large crane manufacturers. A few of the many points of excellence are:

1. Easy one-point adjustment . . . 2. Exclusive anti-drag device . . . 3. They have hardened pins, knurled to prevent rotation . . . 4. They have bushings at points of maximum wear . . . 5. Grease fittings are provided on all hinge pins . . . 6. The friction blocks are extra thick, and bolted to the shoes . . . 7. Wagner provides nation-wide service through twenty-five branches . . . 8. Wagner Hydraulic Braking Systems come to you in complete kits ready to install. They include brake assembly, brake wheel, master cylinder, wheel cylinder, copper tubing, flexible hose, brake fluid and all fittings.

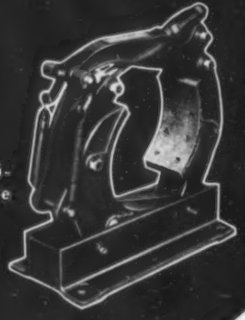
If you are planning on new cranes or conversion from mechanical brakes, it will pay you to investigate the many advantages of Wagner Hydraulic Bridge Braking Systems. Trained field engineers in all of the Wagner twenty-five branches located in principal cities will be glad to consult with you. Bulletin IU-20 will be sent upon request.

BRAKE WHEEL
Furnished with bore as specified

HYDRAULIC PARTS and FLUID
All hydraulic parts and fluid needed for installation.



TYPE HM — Wagner hydraulically actuated bridge brake with automatic parking attachment for outside cranes.



TYPE H — Wagner hydraulically actuated bridge brake for inside cranes.

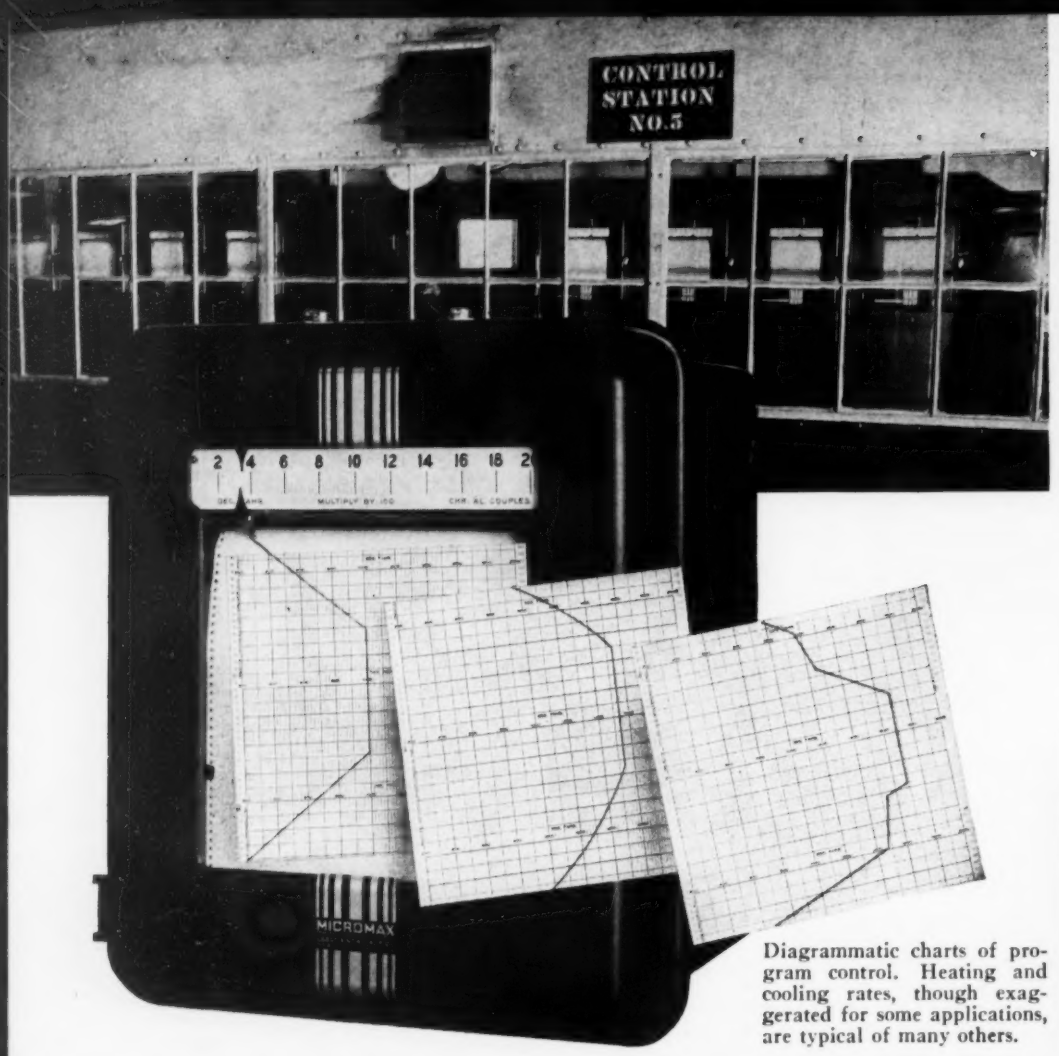
142-1[illegible]

BUY U.S. WAR BONDS

Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

BRIDGE BRAKES • MOTORS • TRANSFORMERS



Diagrammatic charts of program control. Heating and cooling rates, though exaggerated for some applications, are typical of many others.

Can a "TEMPERATURE-BENDING" MICROMAX PYROMETER Help With War Work In Your Plant?

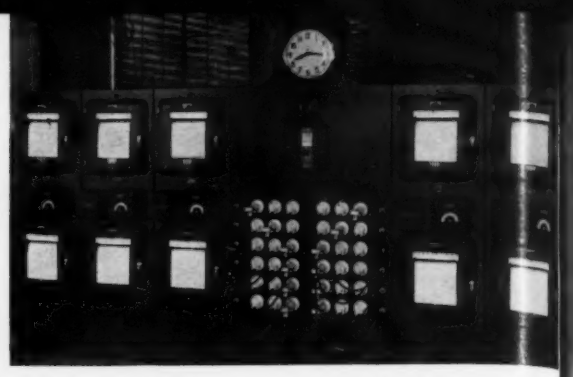
Beginning just a few years ago, in just a few departments, the great steel companies installed their first "temperature-bending" Micromax Pyrometers—Program Controllers which regulate the rate of heating and the rate of cooling, as well as the soak temperature. Temperature-bending is today one of the great forward steps in automatic control; the concerns which started using it have steadily increased their applications; many companies which do not now employ it could save a great deal of time and labor by so doing. Here are a few typical uses:

A furnace charge can be brought up to temperature along a *curved*-line temperature-path, held at temperature without either overheating or falling away, and cooled, at the end of the soak, along any desired curve.

By using a different accessory equipment, the heating and cooling can be straight sloping lines, with temperature increasing or decreasing steadily at a widely-adjustable number of degrees per hour. Or the rate can change several times; it can start at, say, 50°/hr, shift automatically to 10°/hr, and again to, say, 75°/hr, or any other rates permitted by the combination of the furnace, its load and its combustion equipment.

The Control is as accurate during the heating or cooling cycles as during the soak. It is micro-responsive in heading off all upsetting influences, whether they are changes in fuel pressure, in wind or weather, in furnace radiation or load or any other condition. Its fuel valve often moves in response to changes so small they are hard to see on the pyrometer chart; the fuel valve seldom moves widely, but on the other hand, is seldom entirely still, as it holds temperature steadily on the course prescribed by the user for increased output of fixed-quality products.

If you have a problem in which a temperature-bending Micromax Pyrometer could help, send us particulars. Or, you'll find the instruments described in Catalog N-33A, "Micromax Thermocouple Pyrometers"; or N-33B, "Micromax Raytotube Pyrometers."



Typical panel of Micromax Controllers, shipped as a completely-wired unit, ready to install.

Admiral Henry A. Wiley, with Factory Manager W. R. Coley of L&N, pauses for a word with an L&N girl employee at time of Army-Navy "E" Award to L&N.

"E" for L&N

The Army-Navy E was awarded to the Leeds & Northrup Co. on September 5, in ceremonies featured by the presentation of the "E" Burgee to the organization as a whole, and the authorization of "E" Pins to its members.

Admiral Henry A. Wiley praised the Company's attitude, and the results it has produced. President C. S. Redding of L&N, joined by spokesmen for L&N employee groups, pledged continued increases in production. The Company's output consists of classified materiel, in addition to its established lines of instruments, telemeters, automatic controls and heat-treating furnaces.

William L. Batt, Vice-Chairman of W.P.B., voiced the Board's pleasure at having the achievements of Industry so recognized by our armed forces.

Jrl Ad N-33A(18)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

SKF

BALL AND ROLLER BEARINGS

How *to* STOP *Steel Production*

Imagine what would happen if the bearings on these steel mill motors and generators should lie down on the job. The roughing and finishing ends would stop work. So would air compressors, battery equipment, etc. That's why it was so important to select rugged bearings that hold the uniform air gap permanently, prolong motor life, and reduce maintenance costs . . . that can take it from the moment the switch is turned on until it's thrown off. That's why it also pays to handle bearings with *clean* hands and tools . . . to install them correctly with proper tools . . . to lubricate them occasionally with oil or grease recommended by a reliable lubricant manufacturer . . . to protect them from foreign matter and prevent lubricant leakage. A working bearing on a motor today is worth a hundred cripples in motors in the repair shop. 5161

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILADELPHIA, PA.

P-G RESISTORS IN BASIC INDUSTRIES HELP OUR WAR PRODUCTION EFFORT

In these five industries, P-G STEEL GRID RESISTORS play an important part in the production of vital war materials and services ★ ★ ★ ★ ★

Coal Mines

On locomotives, mining machines, loaders, conveyors and other electrically driven machinery.

Coke Plants

On coal hoists, yard cranes, larry cars, door controls, etc.

Steel Mills

On cranes of all types, ore bridges, ore unloaders, charging machines, mill tables and many other kinds of mill controls.

Transportation

On motorized rolling stock for starting, braking, load regulating and speed control service. Also for turntables, shop cranes and battery charging in maintenance work.

Ships

On all types of shipyard cranes and for battery driven yard trucks. On shipboard service for auxiliary control applications such as elevators, hoists, generators and field resistors.

P-G specializes in the production of "Non-Breakable Resistors." Naturally, we take great pride in the intimate association of P-G Steel Grid Resistors with industries that constitute the backbone of the entire War Effort.

Continuous and increasing production of coal, coke, steel, transportation and ships is the keystone of our united drive to victory and to that end P-G devotes its resources.

P-G

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• ESTABLISHED 1892 •

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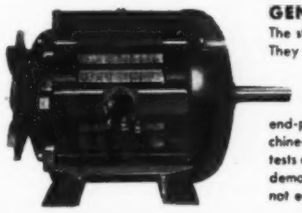
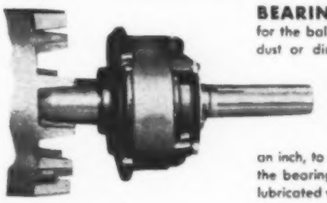
Here's the "INSIDE" Story on WAGNER CP MOTORS

WAGNER type CP totally-enclosed fan-cooled motors have two frames: an outer frame which guides a strong draft of cool air over the motor, and an inner frame which protects the vital parts of the motor against the entrance of metal dust, filings, steel chips, and other destructive agents. Ball bearings are used throughout. Cartridge completely seals the bearings against dust and dirt even when the rotor is removed from the motor. Endplates are machined to accurate dimensions for close frame fit. • • It is because of such features and those illustrated and described below that Wagner CP totally-enclosed, fan-cooled motors have been accorded a wide acceptance by steel mills and metal working plants.

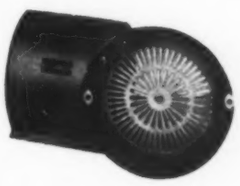


GENERAL CONSTRUCTION. The stators are practically unbreakable. They are constructed entirely of steel, with the component parts welded together to obtain maximum strength with minimum weight. The end-plates are cast iron, accurately machined for perfect stator fit. Laboratory tests and extensive field experience have demonstrated conclusively that dust does not enter Wagner CP motors.

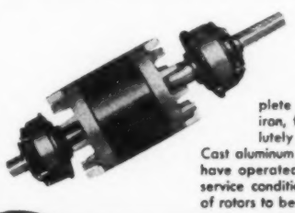


BEARINGS. Full cartridge construction for the ball bearings makes it impossible for dust or dirt to reach them even when the rotor is removed from the motor. The cartridges are heat treated, and then machined to dimensions which are held to tolerances less than a thousandth of an inch, to match the accurate dimensions of the bearings. Wagner CP motors are quickly lubricated without interrupting their operation.

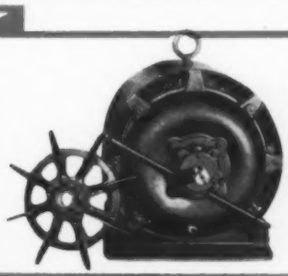
WINDINGS. The windings are insulated with the best materials obtainable, used in generous amounts. The windings are pre-formed to exactly fit the stator slots without crowding. They are effectively insulated from the stator punchings by cuffed slot cells made of tough fibrous material. The exposed parts of the windings are completely taped well into the slots, and the assembled stator windings are treated with high-grade insulating varnish, giving the coils a glossy surface for easy cleaning.



STATOR AND FAN SHIELDS. The stator shield is formed from steel plate and is rigidly bolted to the motor frame. The fan shield is also formed from steel plate with the grating as an integral part of the shield. No wire mesh is used because of its susceptibility to rapid erosion in unfavorable atmospheres, and its lack of rigidity and consequent inability to protect the ventilating fan. Because of close tolerances and snug fit between stator and fan shields, the motor presents a streamlined appearance.



ROTOR. The squirrel-cage is of aluminum, cast under heavy pressure to completely fill the closed rotor slots and the moulds which form the end-rings. The rotor bars and end-rings make complete and intimate contact with the core iron, facilitating heat transfer and absolutely eliminating squirrel-cage vibration. Cast aluminum rotors are not an experiment. They have operated successfully for many years under service conditions which have caused other types of rotors to become brittle and fail in a short time.



VENTILATION. The air ducts of Wagner CP motors are extra large and do not become clogged by dust or dirt. The ventilating fan is of aluminum, does not produce sparks when accidentally hit by metal, and moves a large volume of air at high velocity.

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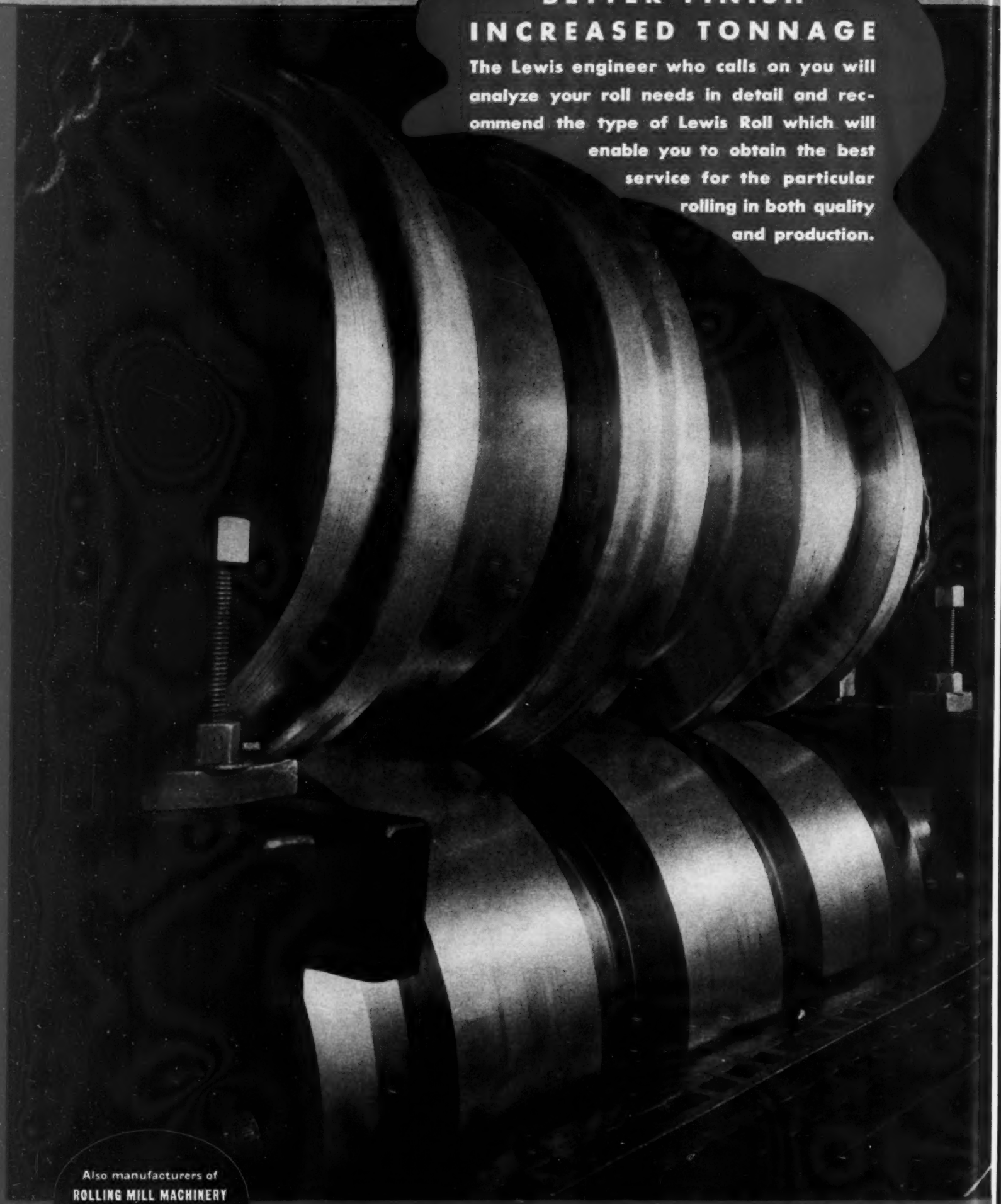

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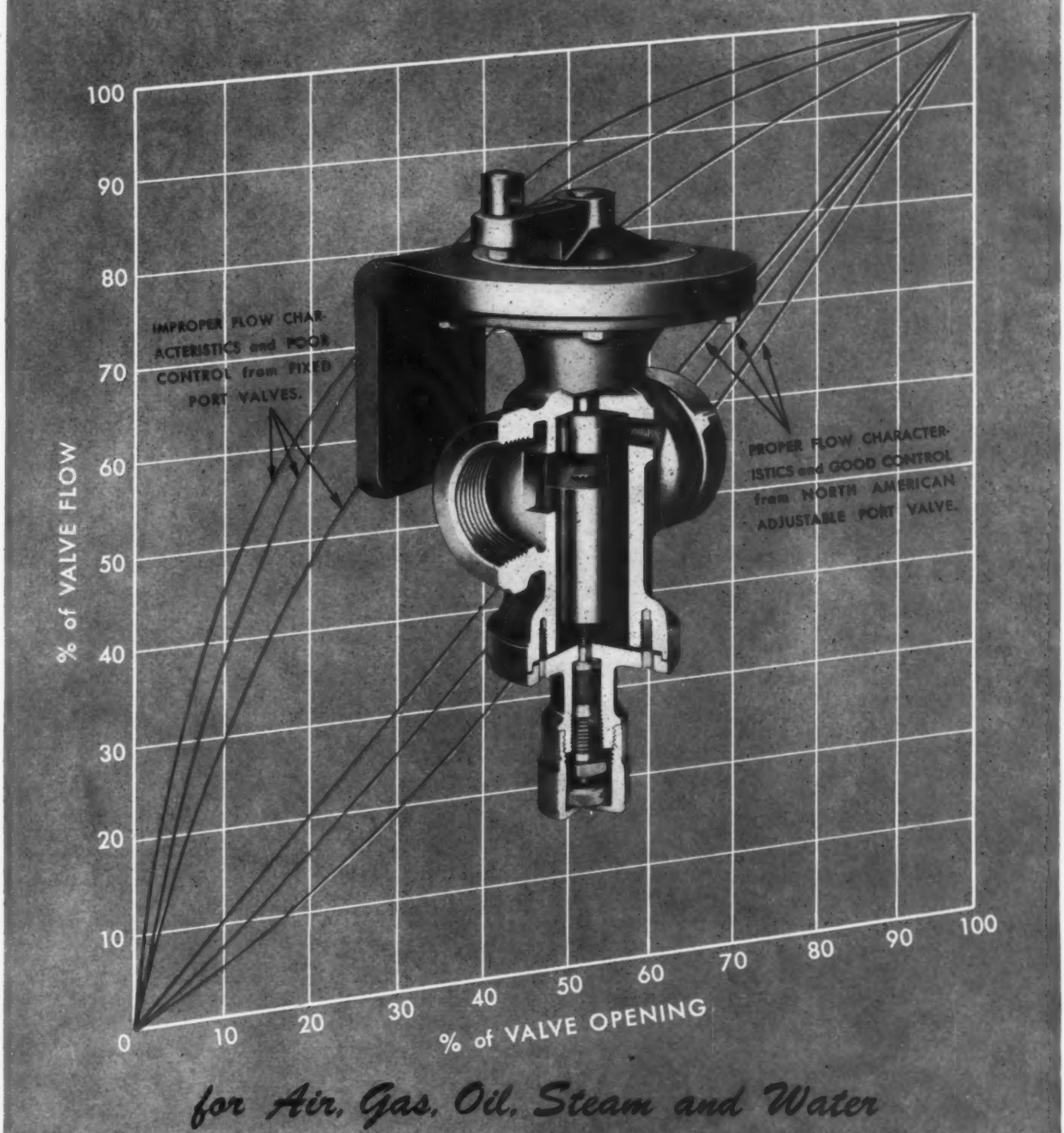

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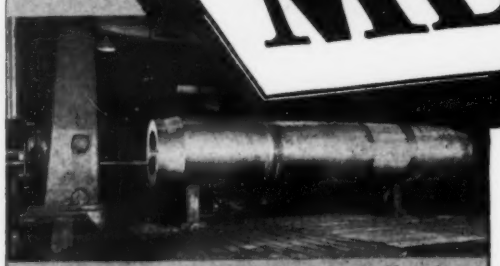
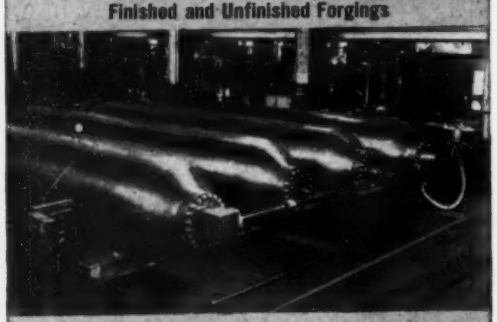
MESTA Forgings

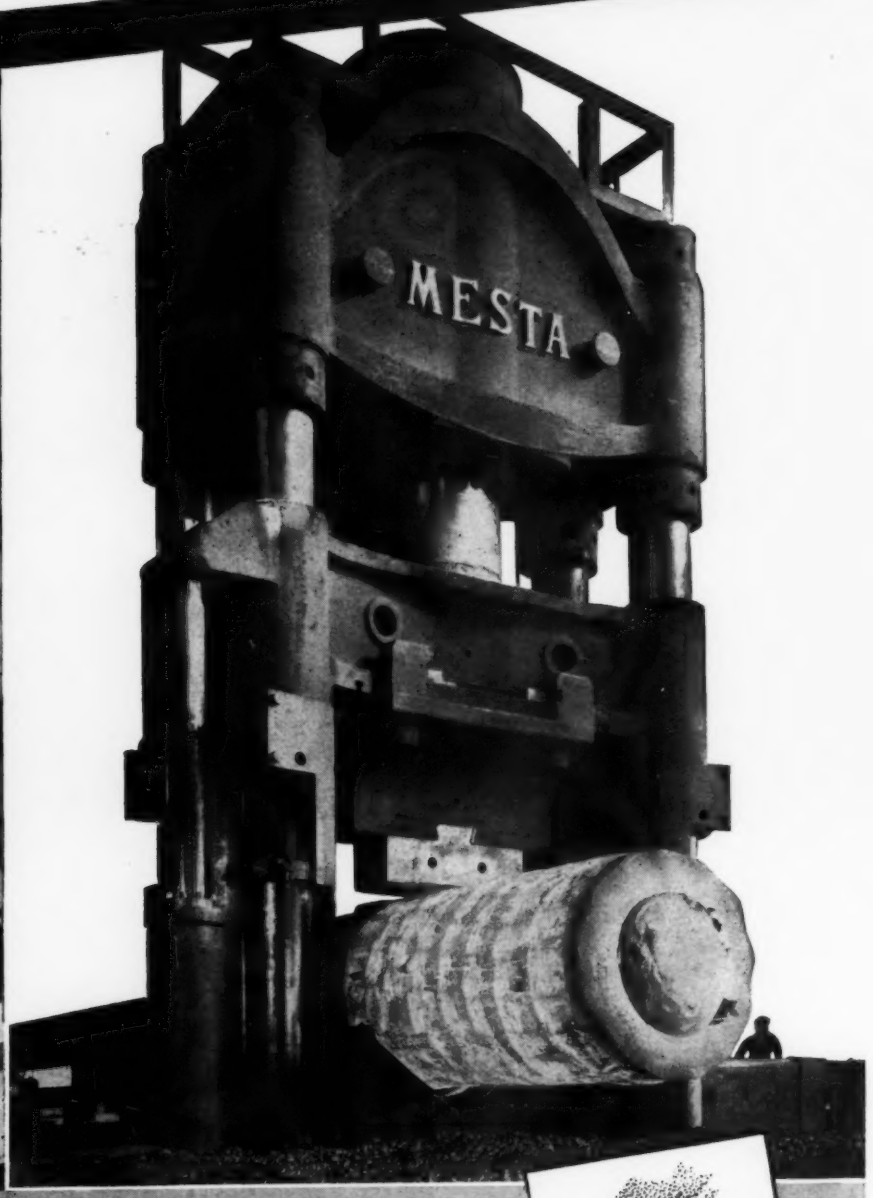


Machining Forged Steel High Pressure Vessel

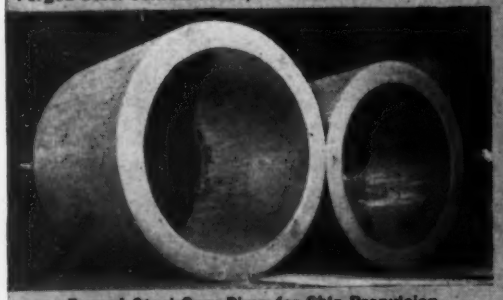
Finished and Unfinished Forgings



Forged Steel High Pressure Vessels

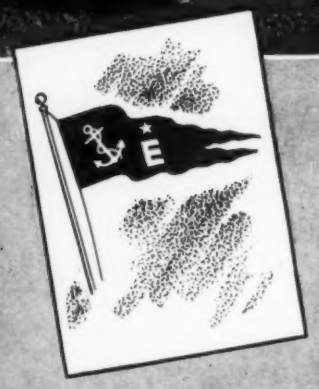


Forged Steel Column for 14,000 Ton Armor Plate Press



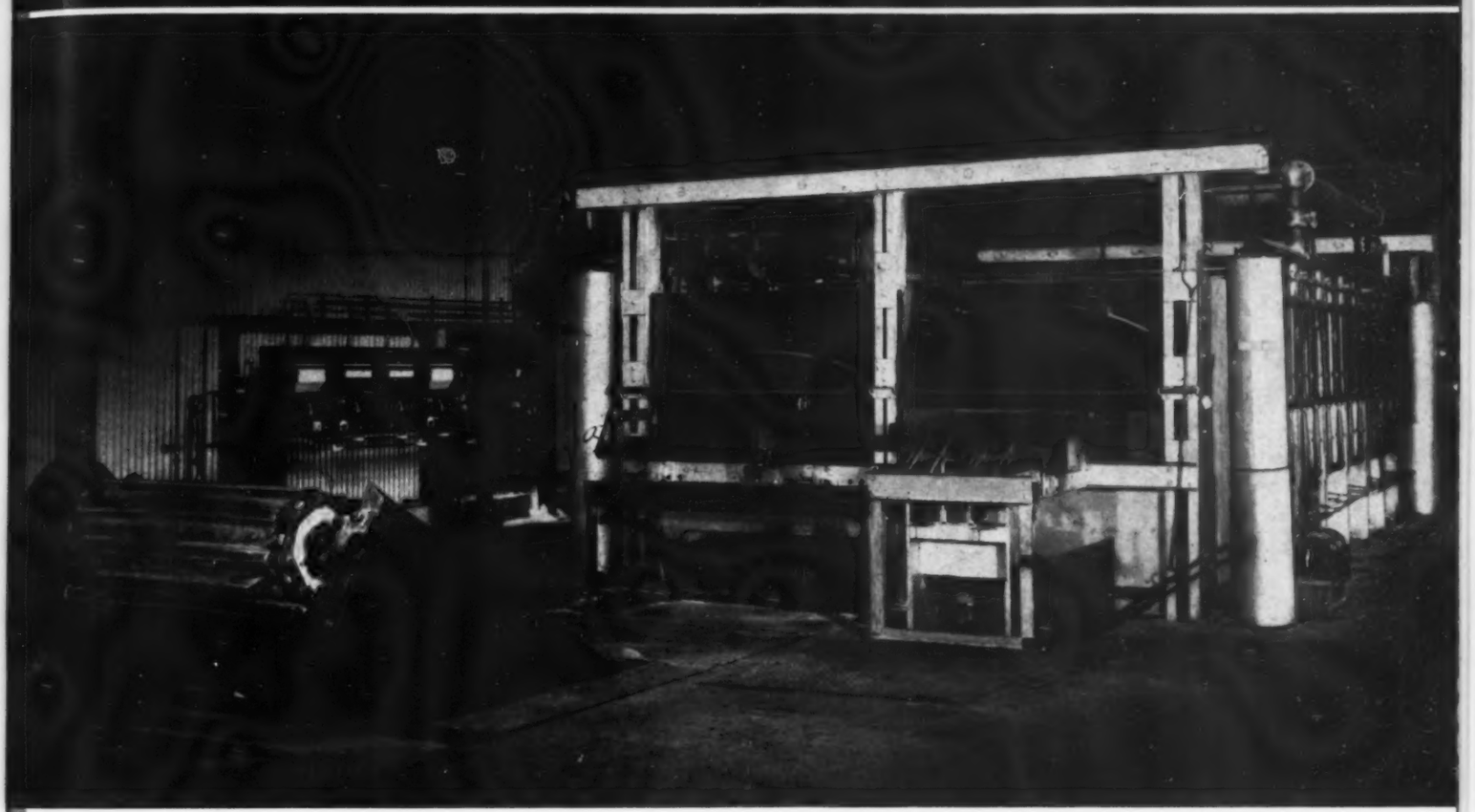
Forged Steel Gear Rims for Ship Propulsion

Forged Steel Ship Shafting



MESTA MACHINE COMPANY • PITTSBURGH, PA.

HEATING FOR DRAWING AT 2000 LBS. PER HOUR



Salem Furnace Offers *Speed and Accuracy*

This Salem Continuous Pusher Type Furnace has a chamber for hardening and another for drawing. The equipment is fired with oil and maintains heat in the two chambers at 1500° F. and 1200° F. respectively. Trays which move over special alloy steel rollers carry the material through the furnace. Two men operate the equipment. One feeds material to the hardening chamber. The parts are discharged from inside of this chamber through a special chute which carries the parts onto a conveyor in the quench tank under the furnace. The conveyor supplies the second man with the quenched parts which he places into the drawing chamber.

The capacity of this furnace depends upon the number and weight of the pieces as well as the nature of the steel, its absorbing ability, etc. However, these Salem furnaces will ordinarily heat miscellaneous forgings at the rate of 2000 pounds per hour. The fully automatic controls give combustion accuracy which holds scale to a minimum.

These furnaces will operate for years without major repairs. . . . Write Salem today regarding your heating problem.

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Even More...

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The Treasury's decision to increase the limitations on the F and G Bonds resulted from numerous requests by purchasers who asked the opportunity to put more money into the war program.

This is not a new Bond issue and not a new series of War Bonds. Thousands of individuals, corporations, labor unions, and other organizations have this year already purchased $50,000 of Series F and G Bonds, the old limit. Under the new regulations, however, these Bond holders will be permitted to make additional purchases of $50,000 in the remaining months of the year. The new limitation on holdings of $100,000 in any one calendar year in either Series F or G, or in both series combined, is on the cost price, not on the maturity value.

Series F and G Bonds are intended primarily for larger investors and may be registered in the names of fiduciaries, corporations, labor unions and other groups, as well as in the names of individuals.

The Series F Bond is a 12-year appreciation Bond, issued on a discount basis at 74 percent of maturity value. If held to maturity, 12 years from the date of issue, the Bond draws interest equivalent to 2.53 percent a year; computed on the purchase price, compounded semiannually.

The Series G Bond is a 12-year current income Bond issued at par, and draws interest of 2.5 percent a year, paid semiannually by Treasury check.

Don't delay—your "fighting dollars" are needed *now*. Your bank or post office has full details.

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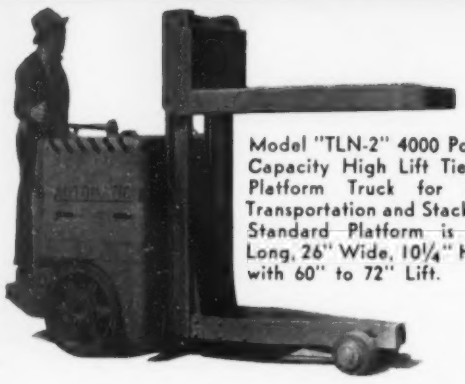
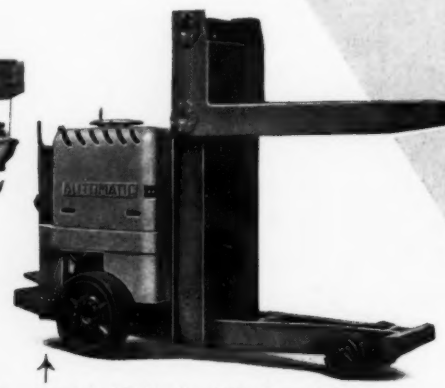
Under General Limitation Order L-112 and supplemental order L-112-A issued by WPB, "AUTOMATIC" standard approved models are illustrated and described here.



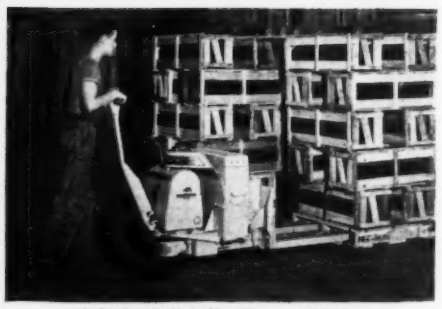
Model "TLN-2" 4000 Pound Capacity High Lift Tiering Platform Truck for Skid Transportation and Stacking. Standard Platform is 55" Long, 26" Wide, 10¼" High with 60" to 72" Lift.

Model "LN-3" → Standard 6000 Pound Capacity Low Lift Truck Equipped with Manual Operated Boom and Motorized Crane attachment. Capacity 2000 Pounds at 42" Outreach.



Model "TLN-3" 6000 Pound Capacity High Lift Tiering Platform Truck for Skid Transportation and Stacking. Standard Platform is 55" Long, 27" Wide, 10¾" High with 60" to 72" Lift.

TRANSPORTER



Model "P-427" Pallet Type 4000 Pound Capacity "TRANSPORTER" Fork Type Lift Truck. Standard Established Fork Lengths Are Minimum 30" to 60" Maximum in 2" Steps. Standard Fork Height in Low Position is 3⅜". Lifting Height from Low to High Position Is 3¾" (Get P-427 Bulletin for Full Details).

Model "CHTF-2" Center Control-Light Duty 2000 Pound Capacity Telescopic Tilting Tiering Fork Lift Truck for Unit Loads on Pallets or Skid Platform. Standard Forks Up to 36" Long. Telescopic Lift Up to 119".

Model "THTF-L-4" Center Control 4000 Pound Capacity Telescopic Tilting Tiering Fork Lift Truck for Unit Loads on Pallets or Skid Platforms Standard Forks Up to 36" Long. Telescopic Lift Up to 119".

Model "TLO-5" 10,000 Pound Capacity High Lift Tiering Platform Truck for Skid Transportation and Stacking. Standard Platform is 60" Long, 26¼" Wide, 11" High with 60" to 72" Lift.

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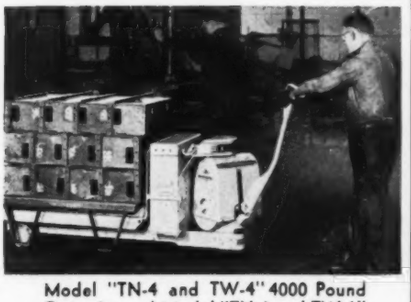
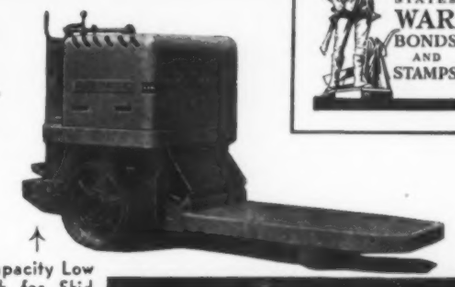


Model "TN-4 and TW-4" 4000 Pound Capacity and Model "TN-6 and TW-6" 6000 Pound Capacity "TRANSPORTER" Platform Type Lift Trucks for Skid Platforms — Standard Platform Lengths 36" to 72" in 12" Steps. Widths 20" and 26½"; Heights in Low Position 6"; 7"; 9"; 11"; (For Full Details Get "TRANSPORTER" Platform Bulletin).



Model "LN-2" 4000 Pound Capacity Low Lift Elevating Platform Truck for Skid Transportation. Standard Platform Is 55" Long, 26" Wide, 10¼" High with 6" Lift.

Model "LO-5" 10,000 Pound Capacity Low Lift Elevating Platform Truck for Skid Transportation. Standard Platform is 60" Long, 26" Wide, 11" High with 5" Lift.

Model "LN-3" 6000 Pound Capacity Low Lift Elevating Platform Truck for Skid Transportation. Standard Platform Is 55" Long, 27" Wide, 10¾" High with 6" Lift.

Model "TETF-7" Rear Control 7000 Pound Capacity Telescopic Tilting Tiering Fork Lift Truck for Unit Loads on Pallets or Skid Platforms. Standard Forks Up to 36" Long. Telescopic Lift Up to 119".

NOTE:—Some "AUTOMATIC" approved models can be furnished with specifications meeting "Industrial Truck Association Spark-Enclosed Equipment" for operation in heavily laden dust or vapor atmosphere such as in arsenals, ammunition depots and ordnance or chemical warfare plants. These are models "LN-2"; "TLN-2"; "THTF-L-4"; "THTF-L-6" and "TRANSPORTER" platform and pallet type lift trucks.

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Model "THTF-M-10" Heavy Duty Center Control 10,000 Pound Capacity Telescopic and Non-Telescopic Tilting Tiering Fork Lift Truck for Unit Loads on Pallets or Skid Platforms. Standard Forks Up to 36" Long. Telescopic Lift Up to 98".

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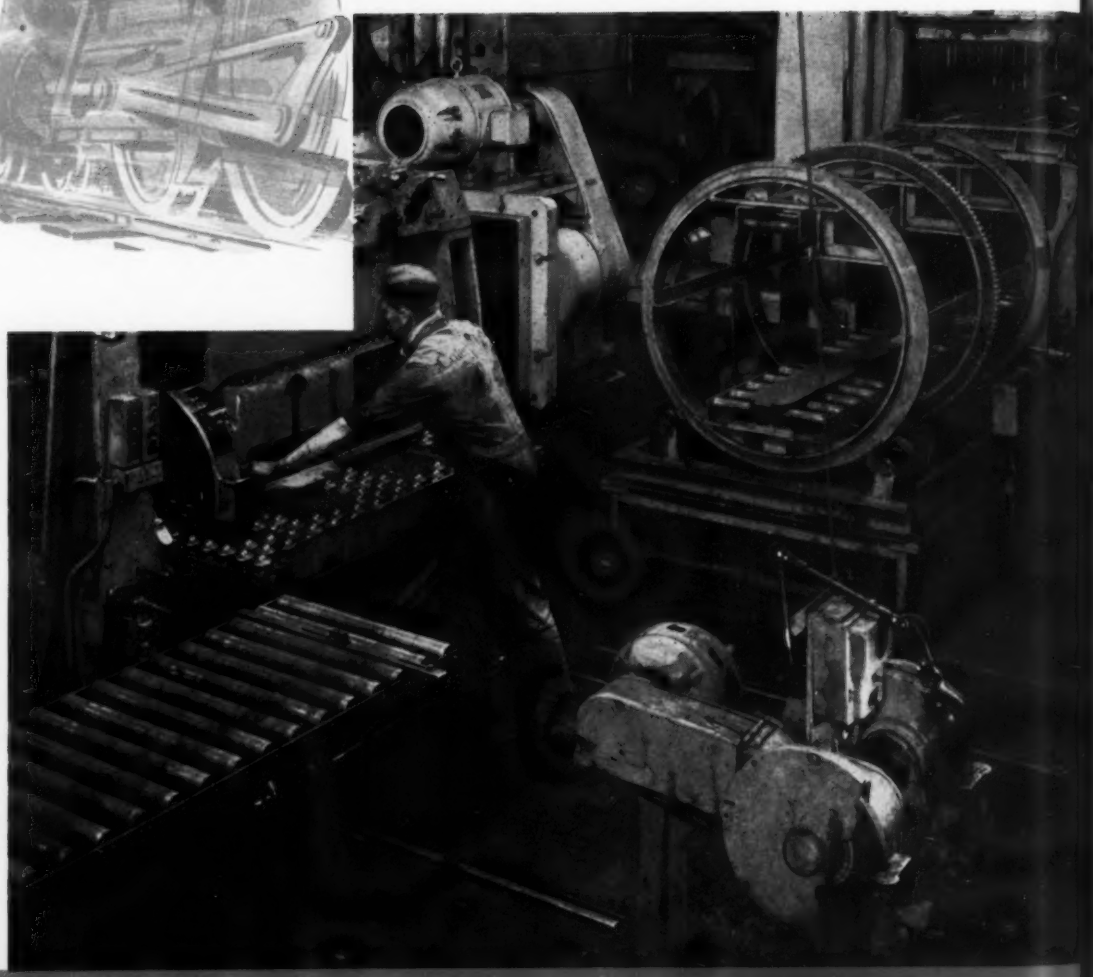

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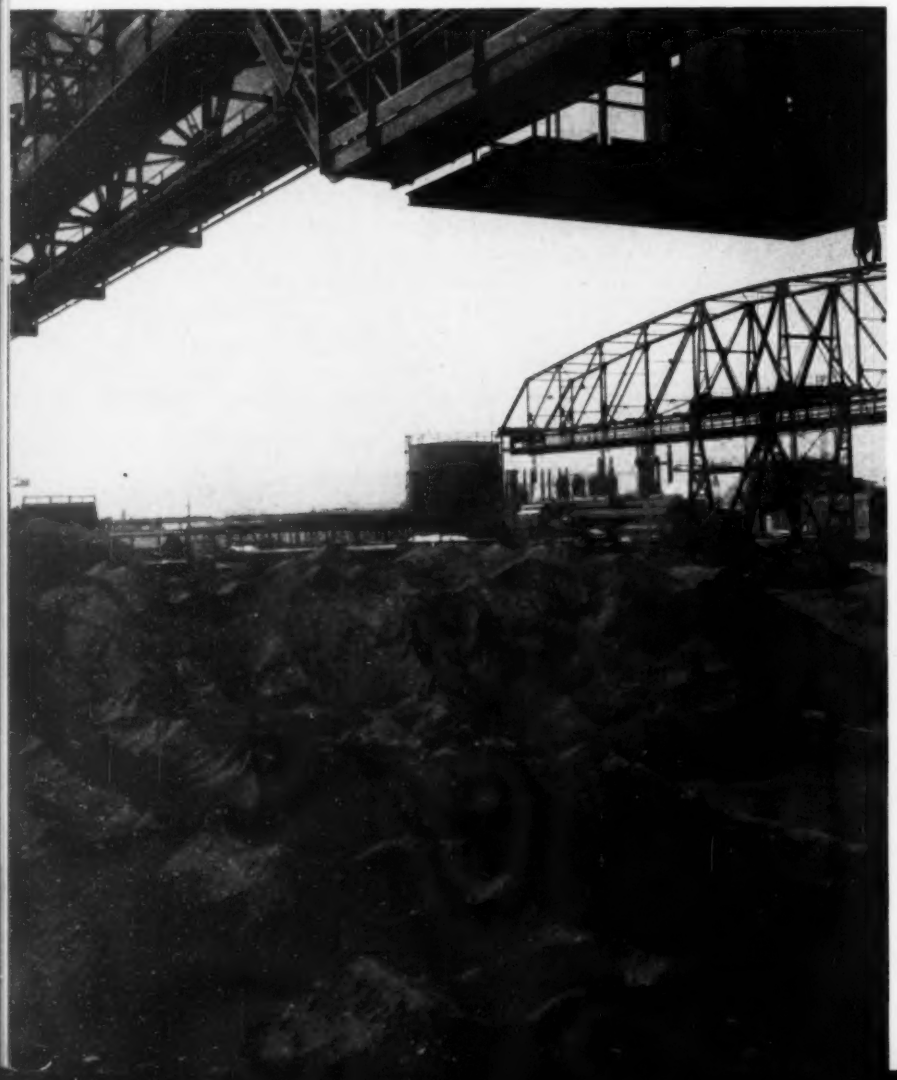
Survey of the IRON ORE, PIG IRON *and* SCRAP *Situation*

. . . . . the greatly increased demand for iron ore is being met by expanding operations in existing mines and by opening new workings . . . . . ore production has not, in general, been held up by inability to obtain equipment, but is threatened by labor shortage . . . . . .

▲ INSOFAR as iron ore is concerned, it is gratifying that the war found this country in a strong position and that the response of the mining industry to the enormous and increasing demands upon it has been immediate and adequate. As most of you know, about 85 per cent of the iron ore requirements of the United States are supplied from the mines of Lake Superior region, and the balance mostly from Alabama and nearby southern states; New York, Pennsylvania and New Jersey which comprise the so-called northeastern district; Wyoming and Utah in the west; together with some imports normally from Chile and Cuba mainly, but some also from Canada and elsewhere. Thanks to the great open pits of the Mesaba range in Minnesota, it has been possible to expand production as needed: and fortunately, the rail and lake ore transportation facilities were such that with limited additional equipment the added burden has been met with remarkable facility. When it is considered that only ten years ago ore shipments from Minnesota, Michigan and Wisconsin reached a low point of only 3½ million tons, and the average tonnage shipped during the ten years ending with 1940 was less than 34 million tons, the probable shipment this year of 92 million tons is somewhat amazing. This compares with 81 million in 1941 and a previous high of 66 million in 1916 — the last war period. Last year more than 22 million tons was shipped from one great pit at Hibbing, Minnesota, which includes the Hull-Rust, Mahoning, Sellers and several other noted properties. To the first of September this season, lake shipments alone exceeded 60 million tons, and were nearly 9 million ahead of last year's movement by that date. All-rail shipments will add another million tons.



Estimated requirements of Lake Superior ore for 1943 and thereafter for the war period are approximately 100 million gross tons, on the basis of the present furnace capacity plus that now under construction and authorized. Ore requirements from all the other districts are increased also, and even some new districts are being opened to supply ore to new furnace capacity in areas which heretofore have not produced iron.

Since the beginning of 1941, 24 large new blast furnaces have been built, or are now under construction or authorized to be completed before the end of next year. Of these, 9 are in areas depending upon southern and western ores. The others are all dependent on eastern and Lake Superior ores — mainly the latter.

To meet the added demands for Lake Superior ore, most existing mines are being crowded to capacity, and new mines have been and are being open-

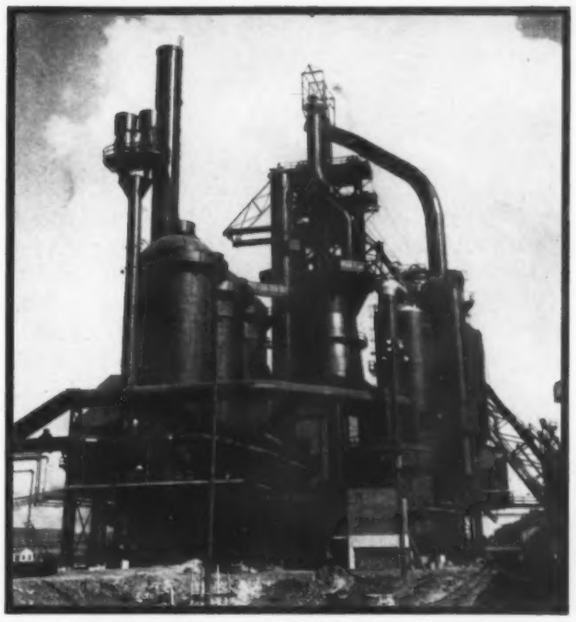
By M. D. Harbaugh

VICE PRESIDENT AND SECRETARY

The Lake Superior Iron Ore Association

CLEVELAND, OHIO

Presented before A. I. S. E. ANNUAL MEETING,
Pittsburgh, Pennsylvania, Sept. 22, 23, 24, 1942



ed. The coming winter season will see unusual activity in stripping of overburden for increasing pen pit operations, and in mining and development work at underground mines. Following the trend of recent years, the open pit operations have gone increasingly to truck and conveyor haulage, with obvious difficulties now precipitated by the rubber shortage. Beneficiation of the low grade ores most amenable to concentration by washing and gravity methods has expanded rapidly. The total output of such concentrates in 1941 was nearly 15 million tons, which is 50 per cent greater than in the highest prior year, and in 1942 it will be considerably greater than that.

While we can thank our lucky national stars for these great natural stockpiles of ore in the Mesaba pits from which most of our expanded war requirements are being presently met, if the war continues for even a few years, the situation is not so rosy. The reserves of commercial grades of ore are distinctly limited, and annual shipments from these at the rate of 100 million tons cannot long be maintained. The State Tax Commission's figures indicate a life of about 12 years at such a rate of depletion, assuming that this rate could be maintained to exhaustion. Obviously, this would be impossible, for about half the reserves are underground, whereas some three-fourths of the wartime production must be met from the open pits which constitute the other half of the reserve. For many reasons, only one of which is labor supply, underground mines cannot expand their operations or output to such a degree or with such facility as the open pits, hence their contribution to the increased demand for ore probably will not much exceed its present magnitude. Thus the open pits must take the brunt of the wartime drain upon reserves, with obvious consequences. The situation is such that the mining industry is giving immediate consideration to plans for an undertaking that it had not expected to tackle earnestly for another 10 or 15 years, namely, the production of high grade furnace feed by large scale concentration of the iron-bearing rock — the taconites — of the Lake Superior ranges. This rock, which contains 25 to 30 per cent iron and twice as much silica, occurs in practically unlimited quantity, for it constitutes the original sedimentary iron formations which were but partly concentrated by nature to form the present commercial ores. Extensive areas of the taconite are magnetic, and it is these magnetites which are most amenable to concentration by presently feasible methods. Other areas embrace hematites and carbonates from which also merchantable products eventually may be won.

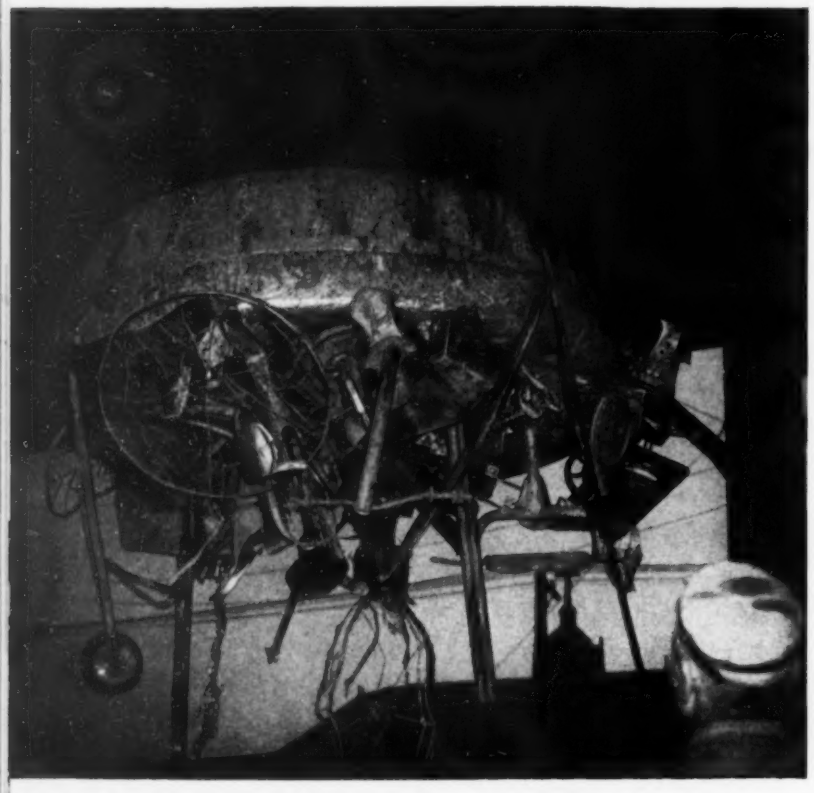
The future welfare of the vast iron and steel industry and of the tributary industries of the lower lakes regions is dependent upon the maintenance of an adequate supply of iron ore from the Lake Superior ranges. No other domestic source is available, and it is clear that our national security demands that this industry never be allowed to become dependent upon foreign ores. Advocates of the St. Lawrence waterway have been telling us for years that we must make provision for large tonnages of South American ores to reach our lake ports to replace waning supplies of Lake Superior ores, but you can visualize the disruption of our industrial life and the threat to our national security that such a policy entails. Given the freedom of action to meet the situation as common sense dictates, and some relief from the new and crushing burdens of taxation which the expanded ore production automatically thrusts upon it, the mining industry may be expected to meet this problem so that there need be no real concern about the future supply of ore. But time has become precious to the solution of this problem, as to many others precipitated by the war, and must not be wasted if we are to rest easy as to our national self-sufficiency.

Three hundred American and more than thirty Canadian vessels have been engaged in the ore trade this season. All of the five large new vessels which one of the shipping companies has been building for the emergency will have made a substantial contribution to the ore movement by the end of this season. And next season will start with ten more new vessels, and six others will be in service by mid-summer.

We are given to understand that adequate measures

have been taken to protect this vital life line of ore from mines to loading docks, through the canals and restricted channels in the lakes, and over the unloading docks and rails to furnace yards. However, to provide a safeguard against the possibility of the Soo canals being closed to traffic, the WPB has recently approved a program to provide an alternate route for the ores from Minnesota to by-pass the Soo by being moved by rail to Escanaba, the port on upper Lake Michigan from which now only some of the Michigan ores are shipped. This project involves a large expenditure for rehabilitation of existing rail lines, enlargement of ore yards, construction of loading docks and possible dredging of the harbor. The job is expected to be completed before next shipping season.

Important additions to iron ore capacity are under way in New York and New Jersey which will nearly



double the output of the northeastern district. The ores in this region are mostly magnetites, and some of the output is high grade lump badly needed for open hearth use, and the rest very high grade sinter. These ores serve to relieve some of the burden on the Lake Superior ores, for they move in part to furnaces otherwise dependent on the latter.

In eastern Wyoming, expansion of ore capacity is under way to supply increased Colorado furnace requirements. Likewise, the ore-producing district of southwestern Utah, temporarily shipping some of its output to Colorado, will supply several additional new furnaces at Provo, Utah; and in southern California the first blast furnace and integrated steel plant in that state will be completed in a few months and will be supplied from one or more sources of iron ore available in that general region and accessible to it. Also in Texas, two new blast furnaces to be placed in operation next year — the first furnaces in that state — will be supplied largely from the surface limonites of northeastern Texas, and one in part from Mexican ores.

Missouri is supplying some ore to the revived furnace operations in the St. Louis district which, however, rely mainly on all-rail ore from the Lake Superior district.

A substantial tonnage of bog limonite ore is being produced from a deposit opened last season in southeastern Minnesota, and exploitation of a low grade magnetite deposit in west central Wisconsin apparently is promising.

Important additions to blast furnace capacity in Alabama already in operation and others to be available in 1943 naturally rely upon expended output of the local ores, the reserves of which are enormous and, next to the Lake Superior region, constitute the most important iron ore resource of the nation. Here also, concentration is beginning to play an important part. The relatively high rates of operation of the blast furnaces and steel plants in Alabama even before the war boom reflected the vigorous and substantial growth of this industry in the south.

While iron ore mines, like others, have had their troubles in getting needed equipment and supplies, production in general has not been held up. Now, however, the threat of labor shortage is ominous, for with the lure of higher wages and other attractions held out to the miners by other industries and war construction jobs unhampered by price ceilings, together with losses from the draft and enlistments, it is just a question of time until iron ore production suffers. The operators are very apprehensive that these mines may soon be up against the same labor problem that already has reduced output of vital non-ferrous metals in many western districts.

I have not mentioned the Canadian iron ore situation, although except for the Newfoundland ores which supply the Nova Scotia furnaces, it is really an integral part of the Great Lakes picture. Nine blast furnaces in Ontario, including two new ones since the beginning of 1941, depend wholly upon Lake Superior ores, and another will be added next year. One plant is supplied in part with high grade sinter produced from carbonate ore from the Michipicoten district north of the Soo, but otherwise these furnaces require ore from the mines of the United States ranges. A second mine is being opened in the Michipicoten district and may be producing high grade lump magnetite late this year. Other possible sources of ore in Canada do not give much promise of early contribution to the war effort of that country.

Now let us discuss pig iron and scrap. With the steel industry in this country geared to the practice of using approximately half scrap and half pig iron in its open hearths, and its operations rarely ever approaching rated steel ingot capacity since World War days, blast furnace capacity prior to 1941 was ample and the flow of scrap iron and steel was adequate to supply iron and steel furnaces and to permit substantial exports in addition.

By 1941 the war abroad and our national defense program had so stimulated this industry that both steel and pig iron output in that year were 60 per cent greater than the average of the five years preceding, as also was the melt of scrap. Whereas pig iron production and

consumption in that five year period were both approximately 35 million tons, and scrap consumption was 37½ million tons, in 1941 these had increased to 56 million and over 59 million tons, respectively. And of the scrap, the purchased tonnage which was supplied by the scrap trade increased from an average of 17½ million to 25½ million tons.

With steel production increased from an average of 52 million tons in the 5 years ending with 1940, to 83 million tons in 1941, and to about 86 million expected for this year; and with capacity being provided for more than 98 million tons by June 1943, an adequate supply of pig iron and scrap presents serious problems, despite all the expansion in blast furnace capacity already referred to. Capacity for producing pig iron and ferro-alloys hovered about 56 million net tons prior to 1941. But by the first of this year it had exceeded 60 million and by the middle of next year is scheduled to reach more than 70 million tons, all of which will be in use. But it takes time to build blast furnaces, and pending completion of all those embraced in the expansion program — and even with their completion — the struggle to keep all the steel furnaces supplied with pig or scrap is certain to be desperate. Scrap, of course, now is the primary uncertainty in the picture, and to maintain an adequate flow to the furnaces requires tonnages so far in excess of what the country normally has yielded that one can but wonder if it exists and can be unearthed. No one seems to know, for the scrap experts say scrap defies statistical analysis. The 25½ million net tons of purchased scrap consumed in 1941 resulted in a substantial drain upon accumulated stocks. All this year there has been apprehension as to the supply, and some furnaces have been long operating on a hand to mouth basis and a few have been idle for lack of scrap. Bureau of Mines scrap figures for this year comparable to those cited for 1941 are as yet available only through June, but for the first six months consumption of purchased scrap was 11.8 million net tons and of home scrap 15.2 million, a total of 27 million tons, showing an indicated rate for the year of some 5 million tons less than the consumption in 1941.

Pig iron from unintegrated plants, meanwhile, is subject to allocation by WPB, as is some scrap also. It is likely that all industrial scrap may soon be so handled. While the widespread public campaigns for scrap collection are doing some good, they seem not to have changed the outlook materially. A new and intensified scrap program, such as some of us talked about nearly a year ago, has just been launched by War Materials, Incorporated, a recent governmental agency created by Metals Reserve and RFC to acquire and move scrap that cannot flow into the trade under existing price ceilings. It promises a practical and vigorous program to collect 5 million tons of high cost scrap and that it will utilize the organized scrap industry largely to do the job.

Numerous observers have noted substantial amounts of scrap in many places that has not yet started to move. And the head of the Institute of Scrap Iron and Steel has repeatedly expressed the opinion that there is adequate scrap in the country to support the war effort. Hence, with the insistence of WPB on an all-out effort to get scrap to the furnaces, and the expanding search for it also by large consumers and others concerned, it appears that whatever scrap there is in the country eventually will be unearthed and made available where needed. However, it seems clear that with the inauguration of scrap price ceilings last year, if the organized scrap industry had been left to function with a little more incentive retained in the business, enough anyway to stimulate rather than destroy many of its normal scrap gathering units, the shortage need never have become so acute and most of the dormant metal would have been unearthed and moved to consumers with less waste of time, energy and expense than is entailed in all the public campaigns. Proper sorting and processing of purchased scrap into some 75 classifications for the trade necessarily requires the services and handling facilities of the organized industry, so there is every reason to encourage it to do the job it alone can best do.

Another important source of scrap now being tapped is the slag and refuse piles of steel furnaces. Of the average loss into such waste of 3 to 6 per cent of ingot production, it is stated that 95 per cent can be recovered by a process of magnetic separation. Such accumulations should yield a very substantial return of scrap.

Despite a lot of publicity and political promotion, it does not appear that sponge iron will contribute anything to the metal shortage. Pig iron made in new large blast furnaces doubtless will continue to be the indispensable source of iron. And as more of it becomes available, and the scrap supply is further reduced mainly to the prompt home and industrial scrap, the steel industry as a whole may be expected to reach a balanced operation whereby it is essentially self-contained. Some integrated plants already have become independent of purchased scrap. High iron charges in the open hearth require much more iron ore in the charge and permit direct reduction of substantial amounts of metal, thus by-passing the blast furnace more effectively than the sponge iron process can. And, of course, as larger supplies of hot metal from additional blast furnaces become available to replace scrap, more of such metal may be treated by partial blowing in the bessemer before charging it to the open hearth, wherever converter capacity is available.

In conclusion of these rather rambling comments, may I observe that this whole industry from the mines to the finishing mills is doing a tremendous task exceedingly well. But from a recent release by WPB we are told that the current production of finished steel products amounting to 5,300,000 tons per month is only a little over half enough to meet the demand of ourselves and our allies, which is now about 9 million tons per month; and that we must mine more ore, build more ships to haul it; build more blast furnaces and more coke plants; and collect more scrap, to keep our expanding steel plants operating at record levels. Truly, the war task assigned to this industry constitutes a challenge which demands all the intelligence, determination and energy that those engaged in its far-flung and coordinated activities can muster. This war must be fought and won with steel, and there can be no fooling from now to the end of the struggle.

The Influence of WATER on the Lubricating Value of Mill Bearing OIL

▲ THE importance of conservation by judicious use, maintenance and recovery of various types of oils which are vital in their application to machinery use in the production of steel cannot be overestimated dring these times of stress.

In an article in Army Ordnance, (Nov.-Dec. 1941 issue) by Capt. G. H. Schoenbaum, the importance of lubrication with respect to our mechanized units was so thoroughly illustrated that I take the liberty of using excerpts from his timely article which quite generally apply to industrial as well as ordnance equipment:

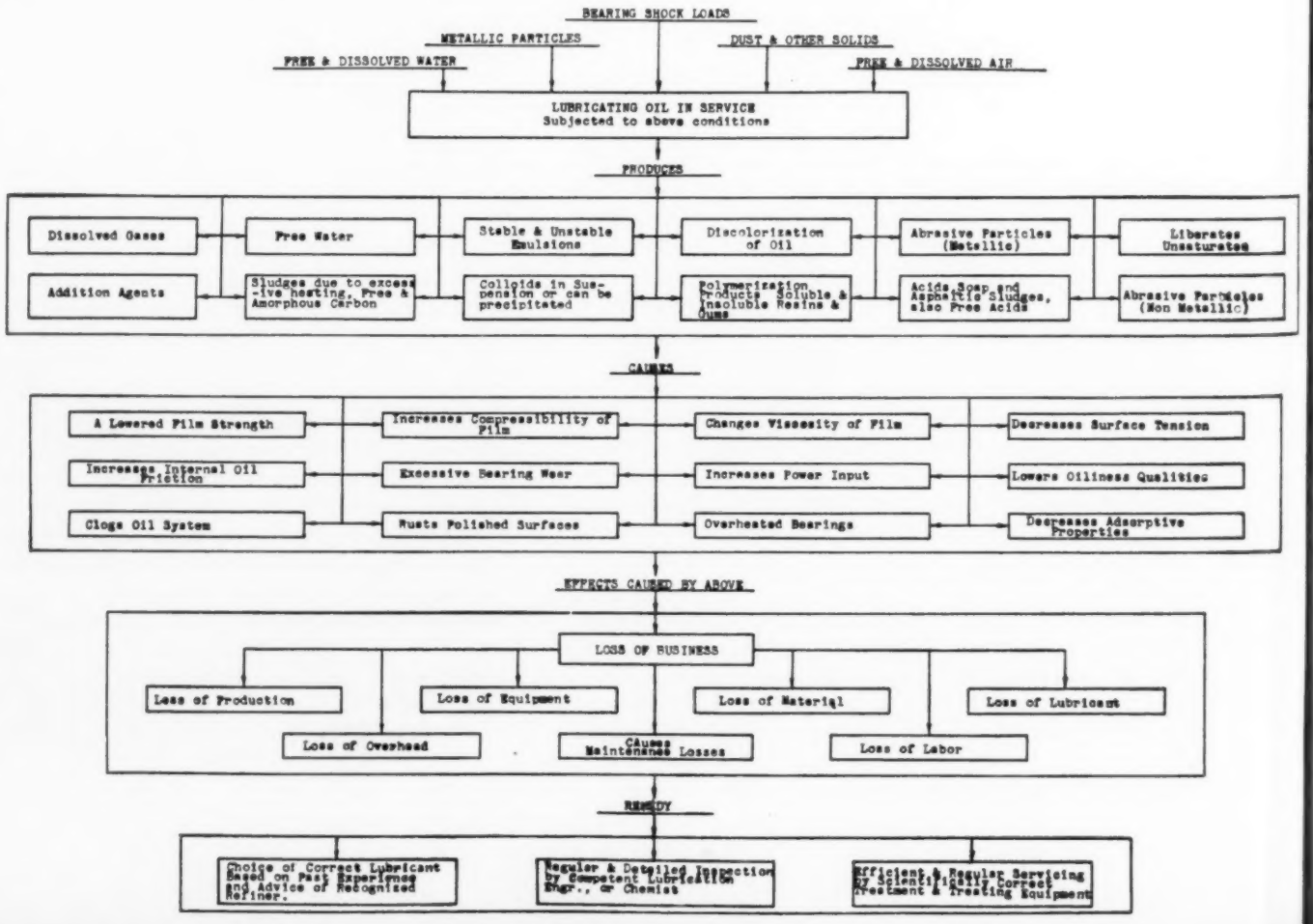
"About the time the fathers of this nation were planning the Declaration of Independence, one of their far-seeing members warned his contemporaries of how important the careful planning of each detail might be come, by publishing these prophetic lines:

For want of a nail, the shoe was lost;
For want of the shoe, the horse was lost;
For want of the horse, the rider was lost;
For want of the rider, the battle was lost;
For want of the battle, the kingdom was lost;
And all for the want of a horseshoe nail!

The moral of Ben Franklin's ditty was well proved later, in the Revolution. These words of warning have a significant bearing on the problem of preparing for the intelligent maintenance of industrial equipment essential in the manufacturing of vital war time products, particularly as it relates to machine tools, rolling mills and electrical equipment. This has been a much-discussed subject in industry for many years. Actually, however, it has been blessed with too few sincere advocates, and even fewer who have successfully put it into practice.

One reason for the failure of preventive maintenance to be universally applied is that no fundamental preventive-maintenance program has been planned and

Figure 1 — Chart showing agencies affecting lubricating oils in service, with the results of contamination and their remedies


BEARING SHOCK LOADS
METALLIC PARTICLES
DUST & OTHER SOLIDS
FREE & DISSOLVED WATER
FREE & DISSOLVED AIR
LUBRICATING OIL IN SERVICE
Subjected to above conditions
PRODUCES
Dissolved Gases
Free Water
Stable & Unstable Emulsions
Discolorization of Oil
Abrasive Particles (Metallic)
Liberates Unsaturates
Addition Agents
Sludges due to excessive heating, Free & Amorphous Carbon
Colloids in Suspension or can be precipitated
Polymerization Products Soluble & Insoluble Resins & Gums
Acids, Soap and Asphaltic Sludges, also Free Acids
Abrasive Particles (Non Metallic)
CAUSES
A Lowered Film Strength
Increases Compressibility of Film
Changes Viscosity of Film
Decreases Surface Tension
Increases Internal Oil Friction
Excessive Bearing Wear
Increases Power Input
Lowers Oiliness Qualities
Clogs Oil System
Rusts Polished Surfaces
Overheated Bearings
Decreases Adsorptive Properties
EFFECTS CAUSED BY ABOVE
LOSS OF BUSINESS
Loss of Production
Loss of Equipment
Loss of Material
Loss of Lubricant
Loss of Overhead
Causes Maintenance Losses
Loss of Labor
REMEDY
Choice of Correct Lubricant Based on Past Experience and Advice of Recognized Refiner.
Regular & Detailed Inspection by Competent Lubrication Engr., or Chemist
Efficient & Regular Servicing By Scientifically Correct Treatment & Treating Equipment

. . . . this first article of a series on "Conservation of Oils Essential to the Steel Industry" reports test results on oils containing water . . . . other contamination of lubricating oils is discussed . . . .

By R. P. Dunmire

VICE PRESIDENT

Buckeye Laboratories

CLEVELAND, OHIO

Presented before A. I. S. E.
CLEVELAND AND YOUNGSTOWN DISTRICT SECTIONS

inaugurated before the equipment it was intended to preserve had been placed in actual service. This line of reasoning thereby accounts for our concern today over the problems of introducing and putting into operation a complete preventive-maintenance program providing for manufacturing equipment.

Of such a program, the lubrication phase is perhaps the most important, even though at first glance it might seem but a detail. It must be remembered that no machine can move without creating friction, and a little friction can wreck a lot of machinery. Thus, lubrication is the 'Achilles heel' of a machine; or, if you please, the 'horseshoe nail' of modern industry.

It is well to point out that the success of our armed and industrial forces may very well depend upon good, sound, preventive maintenance. While lubrication, to the casual thinking person may appear as a trivial detail, one must never forget that 'the best laid plans o' mice and men gang aft agley' because someone neglected to take into consideration the extent to which some small oversight would affect the success of the 'over-all' plans. Let not the war industries which now struggle to build materials with which we must keep our armed forces supplied for action, fail because someone forgot to keep intact the film of oil upon which industry must depend for vital production.

To those responsible for the inauguration and successful operation of a real industrial lubrication program, it seems as though Benjamin Franklin's famous poem can well be paraphrased as follows:

For want of some oil, a bearing was lost;
For want of a bearing, an engine was lost;
For want of an engine, a tank was lost;
For want of a tank, a battle was lost;
For want of a battle, a democracy was lost;
And all for the want of a film of oil!

With apologies to its honorable author, we suggest this as a motto for those responsible for the lubrication of industrial equipment as well as of our modern mechanized equipment."

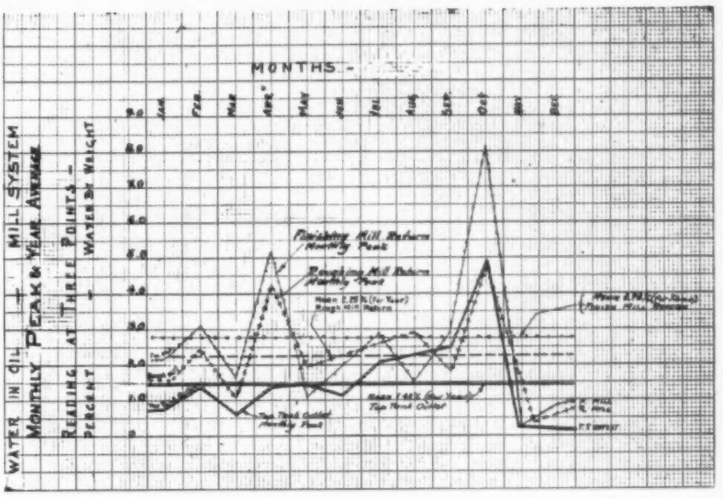
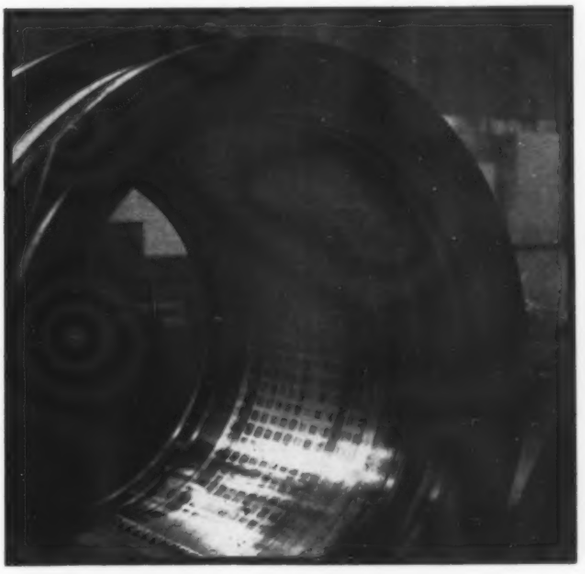


Figure 2 — Record of water content of lubricating oil in bearings of a four-high mill.

The Lubrication Engineer

Lubrication, by which is understood the use of oils or other suitable fluids to diminish the friction between solid surfaces in motion was first dealt with from a purely theoretical standpoint by Prof. Osborne Rey-

Figure 3 — Back-up roll bearing, showing metal movement.



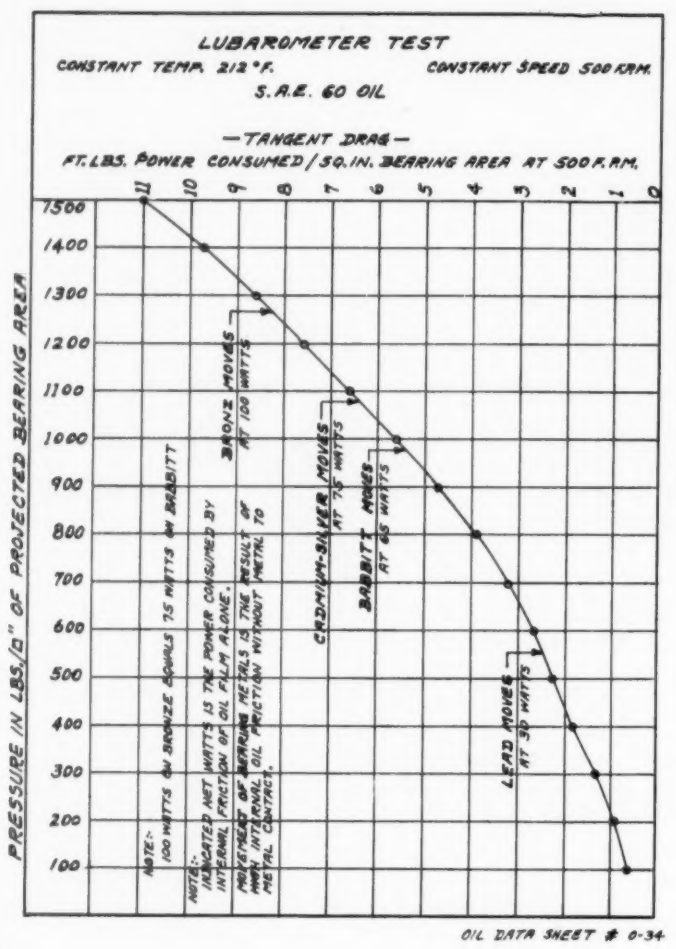
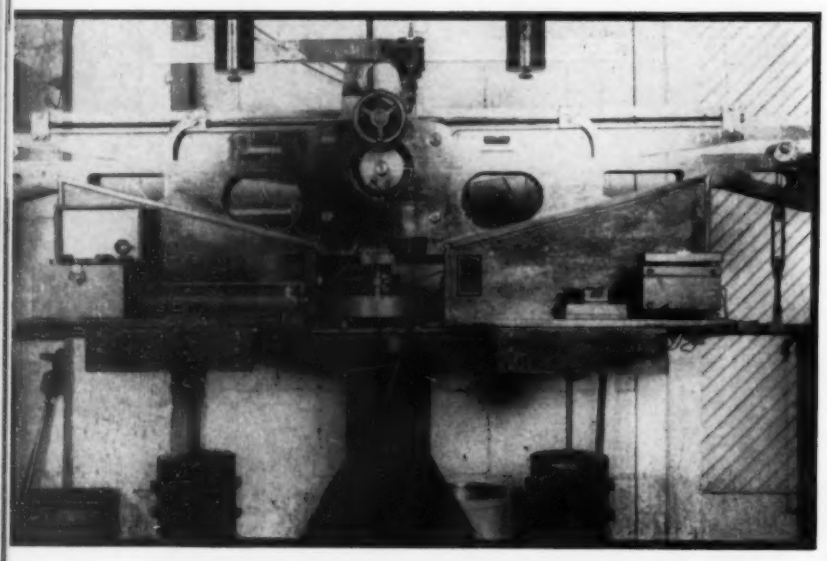

LUBAROMETER TEST
CONSTANT TEMP. 212°F.
CONSTANT SPEED 500 R.P.M.
S.A.E. 60 OIL
—TANGENT DRAG—
FT. LBS. POWER CONSUMED / SQ. IN. BEARING AREA AT 500 R.P.M.
PRESSURE IN LBS./□" OF PROJECTED BEARING AREA
BRONZE MOVES AT 100 WATTS
CADMIUM-SILVER MOVES AT 75 WATTS
BABBITT MOVES AT 65 WATTS
LEAD MOVES AT 30 WATTS
NOTE:- 100 WATTS ON BRONZE EQUALS 75 WATTS ON BABBITT
NOTE:- INDICATED NET WATTS IS THE POWER CONSUMED BY INTERNAL FRICTION OF OIL FILM ALONE.
MOVEMENT OF BEARING METALS IS THE RESULT OF MAIN INTERNAL OIL FRICTION WITHOUT METAL TO METAL CONTACT.
OIL DATA SHEET # 0-34

Figure 4 — Curve showing results of tests of bearing pressure against the tangent drag in the bearing.

Figure 5 — Photograph of the "lubarometer," for determining tangent drag of lubricating oils at various temperatures, speeds and loads.



nolds, in a paper presented before the Royal Society of London, England in 1886.

The experiments performed and the formulae produced as a result of Prof. Reynold's work combined with the reasearch previously conducted by Beauchamp Tower in 1883-4 (Proc. Society of Mech. Engrs.) form the foundation upon which our modern lubrication is built.

"Lubrication engineer" was for many years, to the great majority, a nebulous title applied to the men who "sold oils" or a so-called glorified "grease monkey" who was responsible for the oiling of equipment in plants but without authority to exercise his knowledge of lubrication, if any. Today as a result of the more exacting requirements of modern machinery, "lubrication engineering" is, or should be, recognized as a distinct and separate phase of the engineering sciences. No modern plant executive should overlook or ignore the proffered services of a capable lubrication engineer, whose knowledge makes apparent the fact that his activities will be contributory to greater efficiency, economy and safety of the plant's operation.

Lubrication engineering is by no means to be construed as a new title to be conferred at random, even upon graduates of recognized technical courses. A competent lubrication engineer must have a thorough knowledge of lubrication oils and their proper application, in addition to academic credits in engineering courses. In order to have this knowledge, he must understand thoroughly:

1. The source and refining of lubricating oils.
2. Their chemical and physical properties.
3. A thorough understanding of all makes and types of machinery and their operation.
4. A thorough understanding of the application of the proper lubricants to the many and varied operating conditions of machinery.

The first two requirements can be taught through the usual academic channels, plus a reasonable amount of practical experience. The last two mentioned phases of the lubrication engineer's education can only be obtained by years of practical experience in the field. However, the lubrication engineering student can materially augment his education by co-ordinating his own desire to learn this science of lubrication with a considerable study of the time proven solutions of actual lubrication problems.

Since the advent of World War II, the problems of the lubrication engineer have been increased many fold viz: the scarcity of lubricating oil, sabotage, economical use and conservations of all oils are now paramount.

Colonel H. M. Reedall, Deputy District Chief of the Cleveland Ordnance Dept. aptly states that "Care should be taken to see that equipment, designed for operation at a given speed, is not speeded up beyond safe limits, and maintenance of machines should not be neglected even for an instant. A broken down machine may mean the loss of 100 American lives on some far-off battlefield."

This is definitely a part of the responsibility to be assumed by the lubrication engineer.

The responsibility of the lubrication engineer should not be limited to lubricating oils alone but to all types of oil used in the industry in which he is interested. The

kinds of oil which may be treated economically cover a very wide range. Some of them appear in the following list:

Lubricating oils	Grinding oils
Circuit breaker oils	Quenching oils
Transformer oils	Aircraft oils
Cutting oils	Spindle oils
Hydraulic oils	Edible oils
Turbine oils	Vegetable oils

However, it should be pointed out that to accomplish the best maintenance possible on lubricating oils that the initial investment is going to be slightly greater than for less adequate equipment but the lessening of hazard to operation is really of an insurance nature and the total cost represents only a very small portion of the original investment in major equipment which is definitely dependent on the lubricant for its operation. In a great many cases the loss of production of a single shutdown together with repairs to equipment and the loss of the oil which caused the damage, is in excess of the total cost of adequate equipment for maintaining the oil in the best condition possible.

Deterioration of Industrial Oils

A paper by the author, "Maintenance of Lubricating Oil" giving detailed causes of deterioration of industrial oils was published in July, 1936, issue of *Iron and Steel Engineer*, and the illustrated graphic chart (Figure 1) is of prime importance in the science of lubrication as applied to present day operating conditions.

Since the advent of continuous hot and cold strip mills in the steel industry, the lubrication engineer's problems have been constantly increasing due to exceedingly large quantities of water entering the oil from gland leakage and from condensate in the oiling systems which form an oil-water emulsion which is exceedingly stable. This has proven more of a problem than that of separating scale and other solid materials with which the oil has become contaminated during normal operating conditions. Such conditions are a real hazard to the bearings and may result in shorter bearing life as well as power losses.

A. Fogg and C. Jakeman reported in "The Proceedings of the General Discussion of Lubrication and Lubricants of the Institution of Mechanical Engineers" that, "In the case of lubricating oils such as used for industrial or automotive internal combustion engines, if more than 0.01 per cent of water is mixed with the oil, the seizing temperature is lowered and the minimum friction increased."

The rate of build-up of the huge quantities of water observed in the oil was given careful study by the writer's company in the plant of one of the major steel corporations. Careful observations were made on the settling tanks at three separate positions for a period of one year. The points at which daily samples were taken were at the finishing mill return, roughing mill return and outlet. The data obtained is shown by the curve, Figure 2. While these data illustrate a normal operating condition, it is believed that operating conditions have been somewhat improved since these observations were made. However, the proposition is still quite serious from several standpoints, especially the water contamination.

Examination of a back-up roll neck bearing as shown by the photograph (Figure 3) indicated that some serious action was occurring which caused the appearance of a number of low spots in the bearing which are plainly visible in the photograph. These low spots vary considerably from the standpoint of depth and area as well as position with respect to the axis of the bearing.

After a careful analysis of the situation, it was realized that the shock load-temperature conditions were no doubt responsible. Consequently the reasoning followed that there must be a movement of the babbitt lining occurring under some definite set of operating conditions.

Some time ago Dr. A. W. Burwell and J. A. Camelford made an extensive investigation of some of the aspects of lubrication in which it was necessary to determine the coefficient of friction in a system using

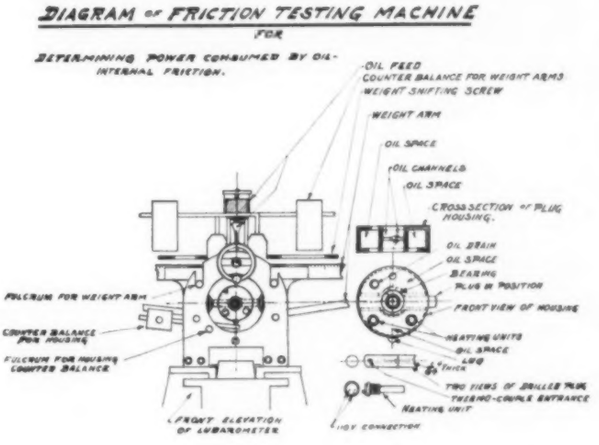


Figure 6 — Sketch showing construction of "lubarometer" illustrated in Figure 5.

many types of lubricants and operating under a wide range of pressures and temperatures. In the course of their investigation they developed the curve as shown by Figure 4 wherein the tangent drag in foot pounds power consumed per square inch of bearing area at constant speed is plotted against pressure in pounds per square inch projected bearing area indicated. It is quite interesting to note the points at which various bearing metals actually moved or were distorted. In the subsequent tests by Dunmire and Camelford, the points at which these movements took place are indicated in terms of watts consumed per square inch bearing area at constant speeds.

It, of course, followed after a study of this curve that there was possibly some relation to these findings and the conditions of the bearing shown in Figure 3. Consequently it was decided that further tests should be made to see what would occur under operating conditions at various temperatures and pressures on four-high mills

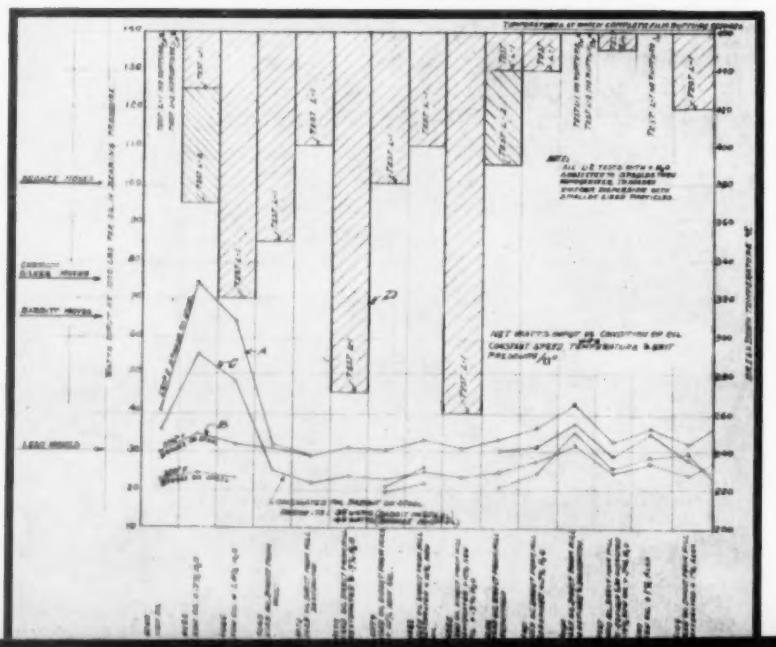
lubricated with an oil-water emulsion. With the cooperation of the Youngstown Sheet and Tube Company a series of samples and tests were carried out and examinations made with a lubarometer as shown by the photograph Figure 5.

A descriptive drawing, Figure 6, shows the construction of the lubarometer. It consists of a one-half hp motor with a steel journal keyed to the shaft. This steel journal forms the shaft of the test bearing, is 1.668 inches in diameter, and the surface is ground to a highly polished finish. The journal is made as hard as possible by using a high carbon steel. Over this is fitted a steel housing with an inside diameter of 1.69 inches, which is supported by a lug so that it floats freely on the bearing. The housing is hollow so that it may be used as a constant temperature or heating bath with oil or other suitable heat transfer medium, and is fitted with two small 200 watt heaters. This housing supports the bearing plugs which are each .80 inch in diameter, giving a projected area of .503 sq in., but the chamfer on the leading edges reduced this area to .500 sq in. They may be made of any bearing metal, and babbitt, bronze, aluminum, and several others have been used successfully. The plugs have their inner surfaces machined to the shaft diameter, and are carefully run in to a smooth fit. After the machine has been in operation for some time, the surface of the plugs presents a smooth dull finish.

The pressure applied to the plugs is altered by means of weights attached to lever arms so that pressure ranges from zero to 5000 psi. The weights are moved by gears and screws along the lever arms so that increase in pressure occurs gradually and without jar to the system. The bearing is lubricated by oil being fed by gravity, and free feed is maintained by means of a needle valve adjustment in the oil reservoir so that the bearing is flooded continuously. The temperature of the bearing is observed by using a thermo-couple inserted in one of the bearing plugs to within $\frac{1}{64}$ in. of the actual bearing surface. During tests the motor speed is kept constant.

After securing the necessary samples from the mill it was decided to secure data which would indicate the net watts per square inch of bearing area at various

Figure 7 — Chart showing relations, as determined by tests, between type of oil and internal oil friction.



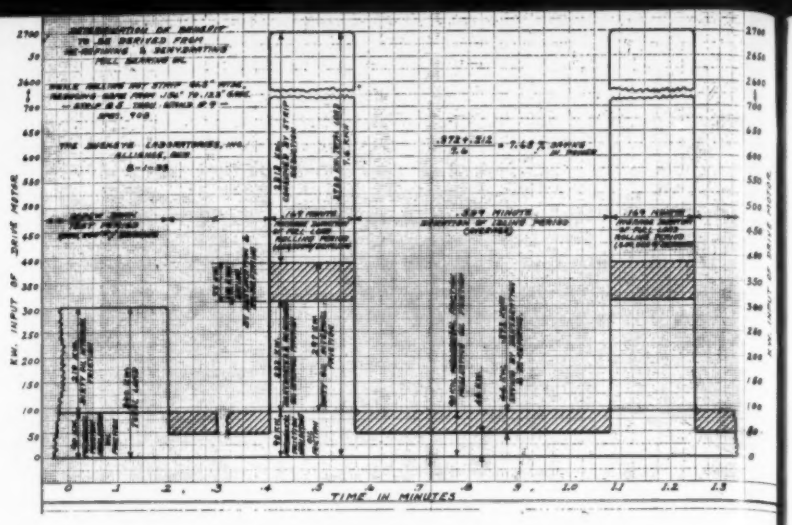


Figure 8 — Chart showing results of tests on power input of four-high hot strip mill with and without water in the lubricating oil.

pressures consumed by internal oil friction while holding the temperature and speed constant and varying the constitution of the oil. The results obtained with respect to power consumed by the internal friction of oils containing water and under other varying conditions within the range of normal operations are clearly illustrated by the following curves: Curve A, Figure 7 — for bronze on steel at 250 F, 500 rpm and 100 psi bearing pressure, Curve B, Figure 7 — for bronze on steel at 300 F, 500 rpm and 1000 psi loading, and Curve C, Figure 7 shows the calculated curve for babbitt on steel at 350 F, 500 rpm and 1000 psi loading. Further tests, as shown by the black diagrams D, Figure 7 were run on the same samples during which the loading was held at a constant pressure of 1000 psi and a constant speed of 500 fpm and varying the temperature. This curve indicates quite clearly that the presence of water offers a serious hazard and quite definitely has great influence on the temperature of the oil film at which film ruptures occurred. The two tests as illustrated by these curves, A, B, C and D combined with previous curve Figure 4 showing the tangent drag values at which the bearing metals move, indicates very definitely that such conditions are a real hazard and that definite precautions should be taken to keep the water content of the oil at a predetermined minimum so as to prevent a rupture of the oil films with the consequent loss of bearings and of valuable production time.

From a further study of the data obtained by the lubarometer tests, it was apparent that if an oil could be operated with a minimum water content, it might be possible to save considerable input-power on equipment such as the modern four-high strip mill where enormous bearing surface areas are present.

A careful study has been made of the power input of a four-high hot strip mill operating under normal conditions with oil having a moisture content of .7 per cent water and comparing it with a rerefined and dehydrated mill bearing oil, the rerefined oil being equal from the standpoint of its physical characteristics to that of new oil. A careful study of the curve, Figure 8 which summarizes the results of our tests indicates clearly that a saving of 7.68 per cent in power supplied the mill was accomplished. Assuming that the average power cost for such a mill is $200,000.00 per year, the resultant savings would be $15,360.00 per year in addi-

tion to the fact that greater insurance against the failure of bearings diminished and oil consumption would be obtained.

An illustration of a system suitable for accomplishing the continuous dehydration of such oils as applied to four-high strip mills is illustrated by Figure 9. It is, of course, desirable in addition to the removal of water from the oil, to periodically rerefine such oils thereby removing the other contaminants previously mentioned so as to return the oils to as good a condition as when delivered by the refiner.

Equipment for the complete servicing of lubricating and certain other types of oil has been designed and is being prepared for production in the near future.

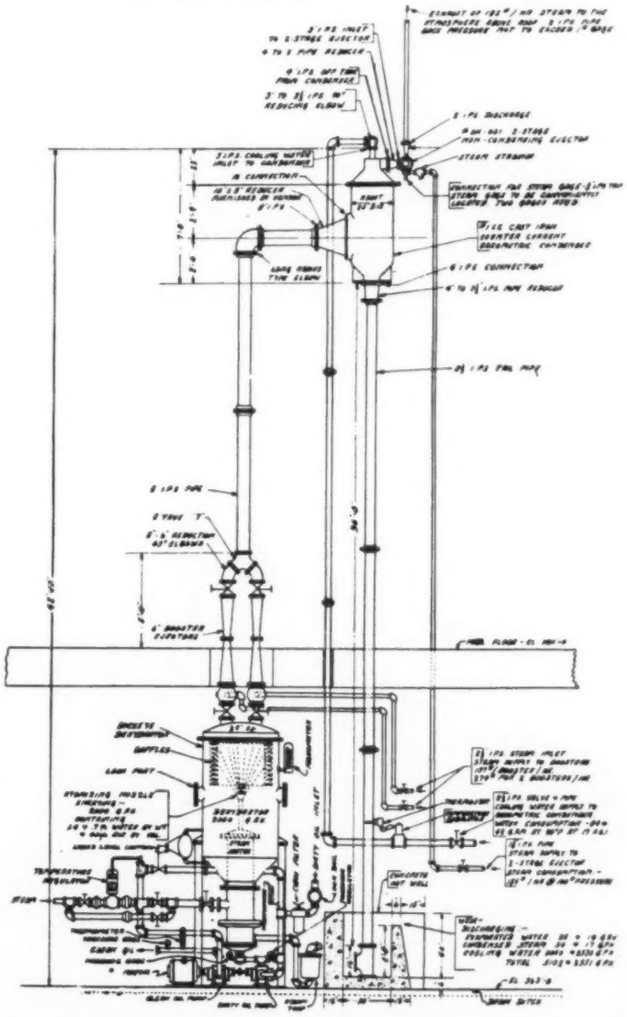
The removal of water, light volatile unsaturates, kerosene, and other products of a like nature, is readily accomplished by low temperature, vacuum distillation.

Higher boiling point, high molecular weight compounds, such as sludge, acids, waxes, soaps, varnish, gums, resins and polymerized compounds which are built up during service and excessive oxidation, are removed by the well known process of adsorption.

Solid substances such as dust, grit, metallic particles, adsorbent materials, and most colloidal sized substances are thoroughly and efficiently removed by either vacuum or pressure filtration.

The removal of such contaminants as outlined above produce oils which are, in most cases, better than they were prior to use under service conditions. Lubricating oils may be easily and economically maintained in the best possible condition by light periodic treatment, for an indefinite period.

Figure 9 — Sketch showing system for continuously dehydrating lubricating oil.



Maintenance of Equipment

It is highly essential to conserve the use of oils as well as maintain them in the proper condition during use. The greatest of all enemies to the use of oil in industry as a whole and most commonly found is that of leakage.

From the data on the leakage chart, Figure 10, it can be readily seen that the question of leakage prevention is paramount. What has been said of the leakage as applied to pipe fittings and valves applies to oil leakage from bearings of all types caused by improper bearing clearance, worn bearings and improper oil pressures. This constitutes a great loss which is usually given little attention as long as the bearings seemingly operate in a satisfactory manner.

The selection of oils of inferior quality quite often results in the burning out of the bearings or the loss of enormous quantities of oil in trying to provide proper lubrication. Therefore the condition of the bearings themselves demands constant attention and maintenance.

There is a marked tendency to over-lubricate as well as under-lubricate bearings and equipment. It is the patriotic duty of the lubricating engineer to see that such bearings are lubricated by the proper grade of oil and maintained in proper mechanical condition so as to assure continuous satisfactory operation of the bearings and without loss of production time.

Abnormal Contamination of Oils

One of the chief concerns of the lubrication engineer is to be able to recognize the introduction of contaminants before using oils in equipment. The most obvious single preventive step is to buy, whenever possible, in bulk rather than in smaller separate containers. Any examination can be carried out on a single sample rather than having to test a multiplicity of samples. In the case of pure petroleum products, a few simple tests are usually sufficient to satisfy the lubrication engineer that the oil is suitable for use — always assuming that purchase specifications have been met by the supplier. Since these tests are qualitative, they may be made very readily by the engineer without elaborate apparatus and in a short time. Following are some general methods which may be of general interests:

A. Abrasives — Emery, carborundum, sand, etc. — A representative sample of oil is taken and diluted with about five times its volume of benzol and filtered or centrifuged. Any non-viscous solvent may be employed, e.g. carbon tetrachloride, but benzol is most rapid and suitable for all types of petroleum oil.

B. Mineral acids and active organic acids (formic, acetic, etc.) — A sample of oil is taken in a beaker, and twice its volume of distilled water added, and then the beaker is set on a hot plate and the water allowed to boil for a minute or two. A few drops of methyl orange solution are added and stirred in. A red coloration in the water indicates the presence of active acids.

C. Dispersed film — destroying materials. — It is pos-

sible to dissolve quantities of some substances in water in fairly concentrated solution and petroleum oils will hold sufficient amounts of such solutions in suspension to cause serious difficulties. Small amounts of carbohydrates, for example, common cane sugar, have been used in several well authenticated instances, and this has proven to be very effective in preventing the formation of the lubricating film of oil which serve the dual purposes of lowering power input to reasonable proportions in comparison with productive work done, and of protecting the very sensitive metal surfaces of bearings and journals, which is of equal importance.

Proof of the presence of this exceedingly destructive material is readily afforded by boiling a sample of the suspected sample with twice its volume of distilled water as above in subheading (B). About 5 cc of the water solution should be taken in a test tube with 10 cc of Benedict's solution — available in any laboratory or from any drug store — and this immersed in a beaker of boiling water for five minutes. A change in color from blue to yellow, orange or red indicates the presence of sugar. While the test would also show the presence of aldehydes, these would never be present in hydrocarbon oils in ordinary circumstances.

A great many lubricants today are compounded with soluble additions to increase film strength, to inhibit oxidation in service, and for other special purpose, and a vast number of substances have been used for this purpose, as a glance at the patent literature will show.

Since chemical tests will show these compounds to be present, considerable care must be exercised in interpreting the results of analysis. Any reputable manufacturer of lubricants will however cooperate with the user by advising either as to the character of compounding agents used or by issuing means of identification or analysis.

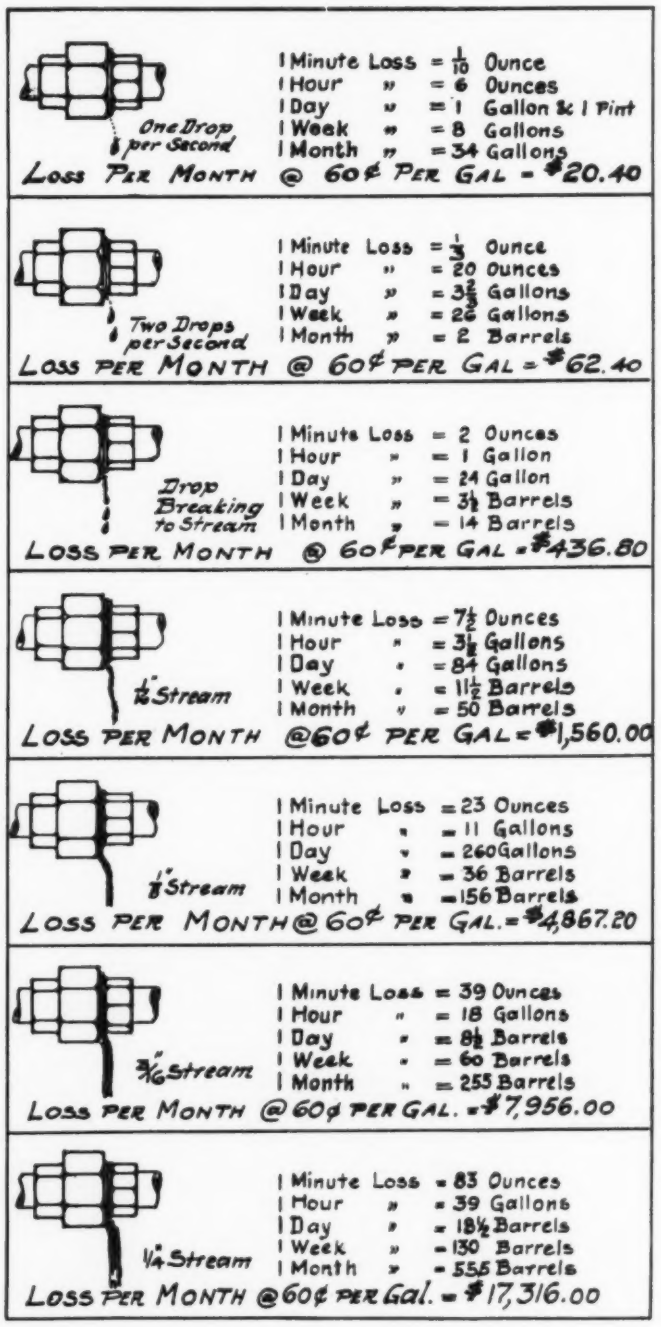
Organic compounds containing chlorine, sulphur, phosphorous and special oxygen compounds are common, and tests showing the presence of any of these must be considered with reference to the possibility of compounding by the manufacturer. However, a very common method of analysis, consisting of incineration of a small sample of oil with calcium oxide (quick lime) will identify the first three members of the group outlined above. If qualitative analysis of a nitric acid solution of the product of burning with lime shows the presence of any foreign material, either metallic or acidic, a check should be immediately made with the supplier. In a case which occurred some time ago, after a sample of oil had been burned with lime, the presence of mercury was noted. Further analysis showed that a compound like phenyl mercury amine had been added to the oil subsequent to shipment by the manufacturer, and considerable damage had occurred before such practice was ended.

Filters having a sufficiently fine degree of filtration to prevent small quantities of solid or abrasive materials from entering the bearings should be installed as soon as possible and should be adequately maintained at all times. It is also essential that oils purchased be shipped in sealed containers and tested to determine not only the quality of the oil but that they contain no foreign materials which would prove injurious to the bearings.

Another function of the lubrication engineer should be the maintenance of quenching oils so as to insure the uniform tempering or hardening of steels. Quenching operations are seriously affected by the presence of water, sludge and scale and should be kept in a highly purified condition so as to furnish uniform production quality.

Many industries utilize solvents for cleaning and other purposes which are normally either burned up or poured into drains. These materials can be easily recovered with proper equipment, thereby conserving these valuable products.

Figure 10 — Chart showing losses from leakage in an oil system.


One Drop per Second
1 Minute Loss = 1/10 Ounce
1 Hour " = 6 Ounces
1 Day " = 1 Gallon & 1 Pint
1 Week " = 8 Gallons
1 Month " = 34 Gallons
Loss Per Month @ 60¢ Per Gal = $20.40
Two Drops per Second
1 Minute Loss = 1/3 Ounce
1 Hour " = 20 Ounces
1 Day " = 3 2/3 Gallons
1 Week " = 26 Gallons
1 Month " = 2 Barrels
Loss Per Month @ 60¢ Per Gal = $62.40
Drop Breaking to Stream
1 Minute Loss = 2 Ounces
1 Hour " = 1 Gallon
1 Day " = 24 Gallon
1 Week " = 3½ Barrels
1 Month " = 14 Barrels
Loss Per Month @ 60¢ Per Gal = $436.80
½" Stream
1 Minute Loss = 7½ Ounces
1 Hour " = 3½ Gallons
1 Day " = 84 Gallons
1 Week " = 11½ Barrels
1 Month " = 50 Barrels
Loss Per Month @ 60¢ Per Gal = $1,560.00
⅜" Stream
1 Minute Loss = 23 Ounces
1 Hour " = 11 Gallons
1 Day " = 260 Gallons
1 Week " = 36 Barrels
1 Month " = 156 Barrels
Loss Per Month @ 60¢ Per Gal. = $4,867.20
7/16" Stream
1 Minute Loss = 39 Ounces
1 Hour " = 18 Gallons
1 Day " = 8½ Barrels
1 Week " = 60 Barrels
1 Month " = 255 Barrels
Loss Per Month @ 60¢ Per Gal. = $7,956.00
¼" Stream
1 Minute Loss = 83 Ounces
1 Hour " = 39 Gallons
1 Day " = 18½ Barrels
1 Week " = 130 Barrels
1 Month " = 555 Barrels
Loss Per Month @ 60¢ Per Gal. = $17,316.00

MOLONEY FURNACE TRANSFORMERS

Water-cooled Moloney Furnace Transformer

ELECTRIC FURNACE shutdowns are costly during normal times, but are even more costly during war times such as these, when lost production time is irreplaceable. Shutdowns resulting from transformer failures are of the most serious type due to the comparatively long time required to make necessary and effective repairs.

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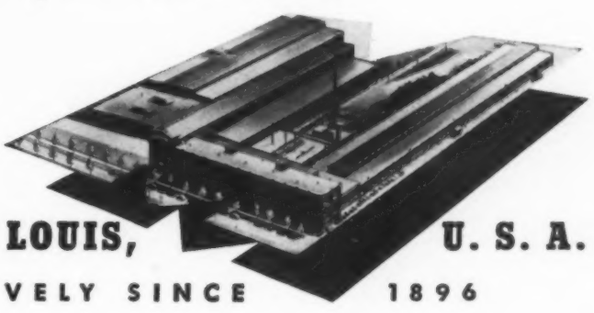
For dependable, trouble-free service, specify Moloney Furnace Transformers.



MOLONEY ELECTRIC CO. • ST. LOUIS, U. S. A.

TRANSFORMERS EXCLUSIVELY SINCE 1896

Trends in the Design of D. C. CONTROL

By H. L. Wilcox
ASSISTANT CHIEF ENGINEER
Electric Controller & Manufacturing Co.
CLEVELAND, OHIO

. . . . with a drop in the introduction of new control elements, developments have been focused on new ways of making standard equipment do more work in less time . . . .

Presented before A. I. S. E.
PITTSBURGH
DISTRICT SECTION

▲ DURING recent months when all control manufacturers have been working in top gear to fulfill defense needs and meet deliveries, there has been a slow-up in the design of new control elements. An additional factor impeding the completion of new design is the restriction on many materials needed for war purposes. These conditions combined with the demand for more output have focused development on new circuits and new ways of making standard equipment do more work in a shorter time.

Machine and mill manufacturers have done their part in speeding up production by new designs which either provide for continuous operation or increased capacity. The initial installations are followed by a period of refinements until at last, the name of a particular mill conveys with it quite a definite understanding of the mechanical equipment and the control involved. The continuous hot strip mill, the welded tube mill, the Fretz-Moon continuous pipe mill, the latest wire blocks, billeteers and ingot scalpers are examples. The advent of these machines invariably calls for new schemes of control using standard control elements to carry out new functions. This is industrial progress with which the control manufacturer must keep step, but there is another phase of progress which is equally important, especially at the present time, and that is, getting most out of equipment already installed which has long been considered standard.

The blooming mill with its roll tables, side guards, manipulators, and screwdown are old institutions which have recently been sent through the clinic with beneficial results. It sometimes takes a national emergency, where everyone is clamoring for the last ton, to bring out these deficiencies of long standing. Then a certain amount of research follows, usually resulting in improvements and an increase in production. It is this trend toward increased output with present equipment to which this paper is devoted, and while the blooming mill has been made the object under consideration, it might apply to many long established systems.

Considering first the front and back roll tables for a

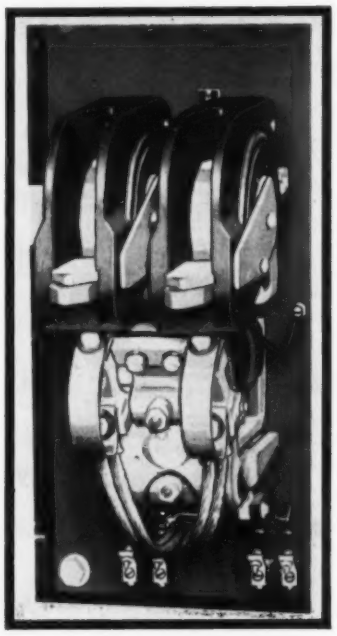


Figure 1 — Single pole 600 amp contactor with .24 sec closing time, .149 sec opening time.

blooming mill, each table may consist of 12 to 15 rolls driven by two 100 to 150 hp motors. In some cases these have been 230 volt compound wound motors operating in parallel from a duplex controller with gear ratio to give roll peripheral speeds of about 480 fpm. Very often this has proven to be too fast and permanent resistance has been connected in to cut down the speed.

The theoretical best horsepower to accelerate the rolls and a hot ingot is a function of the WR^2 of the rolls and gears, WR^2 of the motor, weight of the ingot, coefficient of friction of the ingot on the rolls, and the overall friction of all bearings. The mill builders no doubt have means of calculating this and if such information is not too jealously guarded, it would be a good subject for a paper in itself. Mill users for the most part have to learn by experience, and as one cannot change motors every week, such information takes a long time to accumulate.

A study of the operation of the front and back tables will reveal that it is mostly acceleration and deceleration with very little chance to reach top speed, at least while the ingot or bloom is on the tables. A mill may

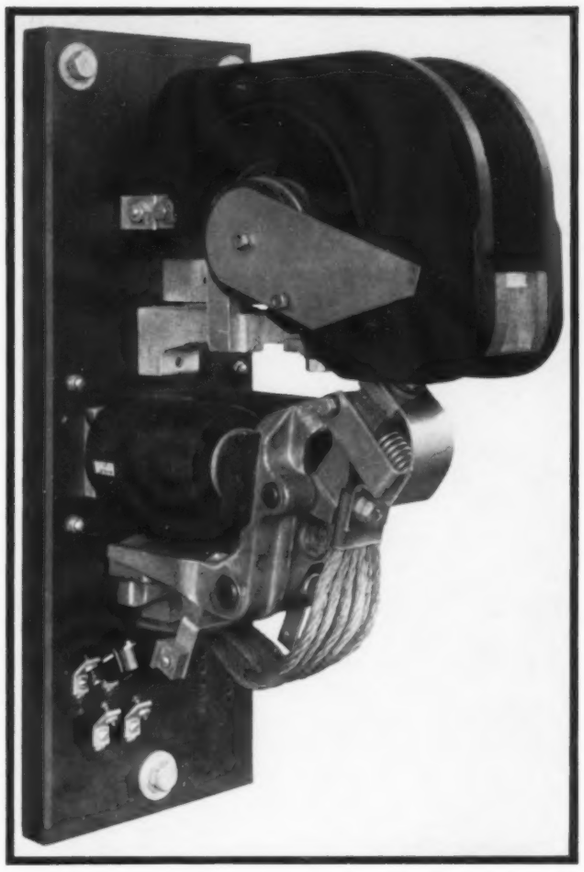


Figure 2 — This contactor, which superseded that shown in Figure 1, has a .163 sec closing time, .117 sec opening time.

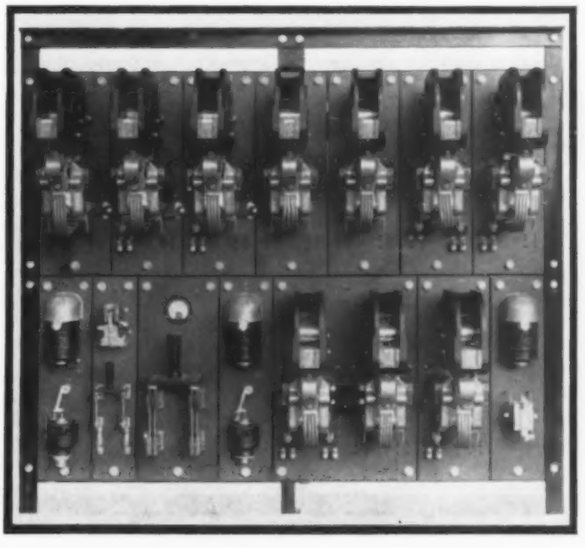
reverse 20 to 25 times in rolling an ingot to a bloom or slab and a fraction of a second saved on each reversal will cut considerable per cent of the time from the rolling of each ingot. It will be apparent that torque is of greater importance than speed. This suggests series motors connected in series. Together, they develop double the torque of one motor, using only the current of one motor, having less WR^2 than a single motor twice as large, and at the same time permits the use of cut-out knife switches to isolate one motor and run on the other in case of motor failure. The two series motors operating in series and having therefor one-half normal voltage on each, will not run away if left running with no load on the rolls. If one motor must be cut out of the circuit for any emergency reason, throwing full voltage on the remaining motor, the latter will not run too fast because it now has double the load.

The tables for one such installation have twelve 18 in. rolls in each table and each driven by two 150 hp series motors connected in series. The control was a special reversing plugging controller which became more special as experience opened the way. Two steps of plugging were provided in order to decelerate the motors in the shortest time without destructive plugging current. Two steps of time-current acceleration were provided giving about .75 seconds per step. The operators called for more speed so the accelerating time was cut to .5 seconds per step. Still they wanted faster acceleration so forced draft was applied to the motors and the acceleration relays were shorted out leaving only the interval of the electric interlocks between steps. Still they called for more speed in acceleration. The motors were not getting too hot, so why not? The contactor coils were changed to intermittent duty coils to make operation faster and later the two steps of acceleration were paralleled and still the ventilated motors ran cool enough. To be sure, two short interval steps of acceleration would have been better than one big step but this experience brings out two points; first, that there is a decided advantage in using forced ventilation for motors of such applications, and second, we need still faster magnetic contactors.

There is a feeling among operators that the need of forced ventilation indicates that the motor is too small for the job. They would like to see a motor big enough to operate without ventilation. A larger motor, however, means greater WR^2 and more power wasted in overcoming its own inertia. The case is synonomous to a runner who must cover a certain distance. He will do it in a much shorter time if his requirements are satisfied on route than if he must carry them with him.

Regarding contactor speed, the above experience indicates that closing intervals of .25 seconds are too slow. The operation of two motors in series represents a circuit of considerable inductance and rupturing this circuit becomes more destructive to contacts and arc chutes. If the arc is not ruptured quickly, the results will be the same as with a sluggish operating contactor. Experience has proved that the most desirable arrangement for such service is to use a double pole negative line contactor with poles connected in series. In some instances, two separate single pole negative line contactors have been used alternately with cut-out knife switches to transfer from one contactor to the other, isolating the first for repairs, but due to the fact that two arcs in series are less destructive than a single arc,

Figure 3 — Reversing-plugging controller for two 150 hp series motors connected in series.



so two poles in series last longer and give better service than two single pole contactors operating alternately.

Such an application therefore requires at least a 600 ampere double pole contactor that will operate in less than .2 seconds. Figure 1 shows the single pole 600 ampere contactor used on the controller described above which had a closing time of .24 seconds and an opening time of .149 seconds. This contactor has now been superseded by the contactor shown in Figure 2 which has a closing time of .163 seconds and an opening time of .117 seconds on normal voltage. Figure 3 shows a reversing-plugging controller for two 150 hp series motors connected in series using this contactor throughout. The double pole negative line contactor, shown near the center of the lower deck, consists of two identical single pole contactors connected by an insulating tie bar and has therefore the same speed and characteristics as the single pole contactor. This being true, we find that the arc is broken at four places by the simultaneous opening of the reversers and the double pole line contactor, and this aids in the speed of operation as well as in contact life.

The manipulator sideguards, used for holding, straightening, or pushing the bloom from one side of the mill to the other, are usually operated in pairs. The left front and rear sideguard are mechanically tied together to make one pair while the right front and rear guards form the other pair. Each sideguard has a motor making the two mechanically connected and these motors are usually compound wound, and connected electrically in series. One pair of sideguards will carry the fingers for turning the bloom and therefore usually takes one size larger motor than the sideguard without fingers. A 35 in. mill may have a 100 hp motor operating the sideguards with the fingers and an 85 hp motor on the other sideguards.

The control is reversing plugging with a certain amount of permanent resistance in the armature circuit to limit the current when the sideguards clamp the bloom or slab. If sufficient permanent resistance is used to limit the stalled current to moderate values, it may prevent the motor from developing enough torque when it is necessary to push a slab across the mill. In any case, it slows up acceleration. In some installations a jam relay has been used, which permits regular acceleration but trips on excessive current to open acceleration contactors. It is usually found that, if the motor is allowed to get across the line before the sideguards stall

Figure 4—Schedule board and differential unit for horizontal screwdown, with plugs and jacks for two schedules.

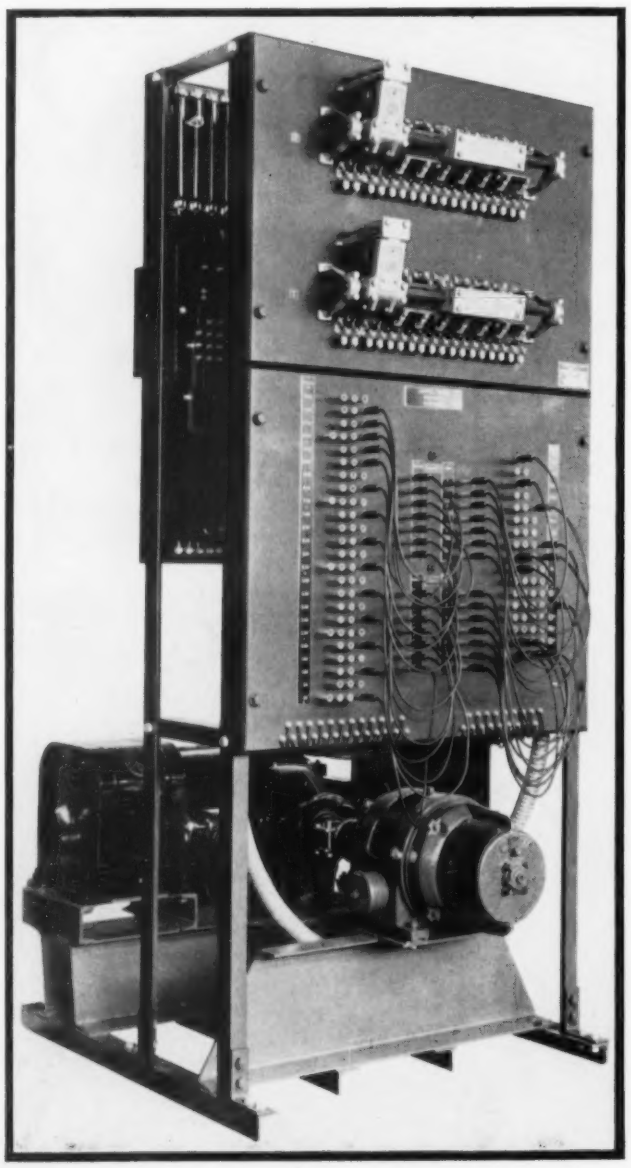
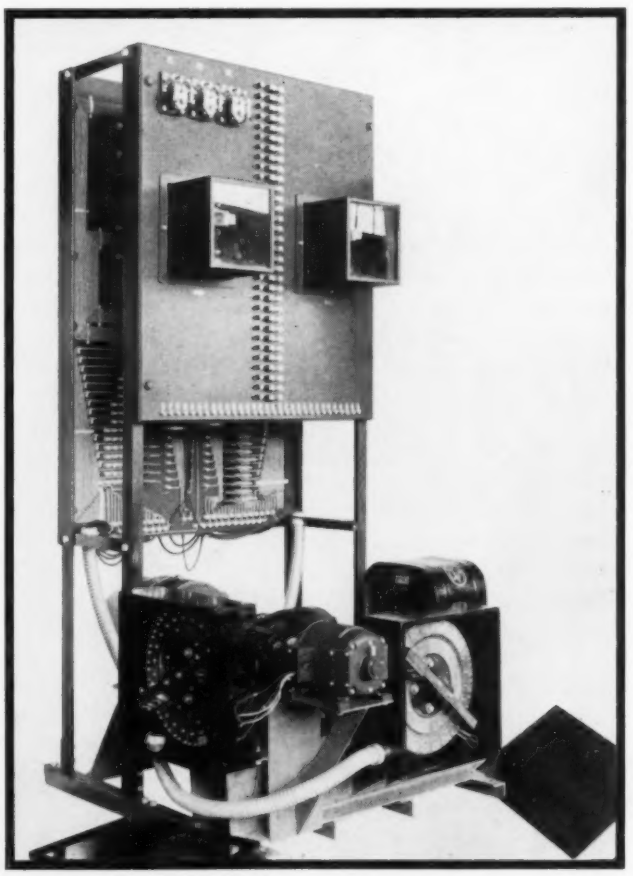


Figure 5 — Reverse side of schedule board shown in Figure 4, with notching relays that select mill passes in proper rotation.



against the billet, the jam relay cannot open the accelerating contactors fast enough to prevent injury. The fastest and safest arrangement consists of a reversing plugging controller including a combination of permanent resistance and a jam relay.

If limit switches are used to stop the sideguards in the full out position, about two points of armature shunt slowdown are essential and particular care must be given in the design to insure that enough torque is developed on the slowest point to retrieve the sideguards, otherwise, when operating near one side of the mill, the sideguards on that side may not develop enough torque to move out. Full out limit switches, if properly installed, are advantageous since they allow the operator to throw his sideguard master to full out and then concentrate on the next ingot on the approach table. This is often difficult of accomplishment since mill builders seldom provide sufficient overtravel of the sideguards to allow for automatic slowdown.

The manipulator fingers are usually driven by a compound wound motor operating through a crank motion. These have been controlled by non-reversing dynamic braking controllers. If the master handle is thrown one way, the crank will revolve 360 degrees and be stopped by a cam limit switch. Throwing the master to the other side will give another operation. It has recently been found more convenient to use a reversing plugging controller with dynamic braking. If the operator throws the master full on, the crank will rotate 360 degrees and stop as before, but if he merely wishes to tip an ingot he can start the fingers up and then reverse the motion. Here, again, fast acceleration is essential.

The screwdowns probably require the most exacting control especially on a mill used for slabbing as well as blooming. For straight blooming work, the roll movements may not exceed 2 or 3 inches and can easily be be accomplished while the mill is being reversed, but for slabbing operations the rolls may have to open or close 20 to 25 inches in going to or from an edge pass. If some form of high speed is not used for these long travels, much time will be lost waiting for the screwdown.

The older installations used two compound wound motors with series parallel control. For short movements, the motors were in series and gave good torque characteristics, but for the longer movements, analysis showed that time was lost due to the discontinuous torque when changing from series to parallel. A more recent method employs two series motors with one or more points of series field weakening for the high speed. For short movements, the motors may have three points of armature resistance acceleration, and for longer movements a fourth point introduces the field weakening which approximately doubles the speed. This high speed point may be applied by a time relay after an interval, which is just sufficient to complete short movements, or it may be applied by moving the master an additional point. This extra point on the master may be made spring-return or require a little more effort so that the operator can use the low speed range without any particular attention but use a little more force to get the high speed for the longer movements

One mill rolled a 4-ton slab each three minutes. This time included 23 passes in which five of the screwdown movements required 9, 12, 14, 10 and 15 seconds making a total of 60 seconds. By cutting these long move-

Figure 6 — Typical rollers desk, including control for edger roll screws as well as for horizontal roll screws.

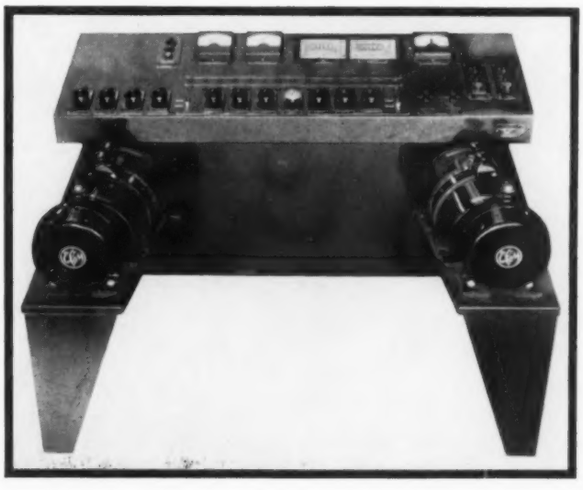
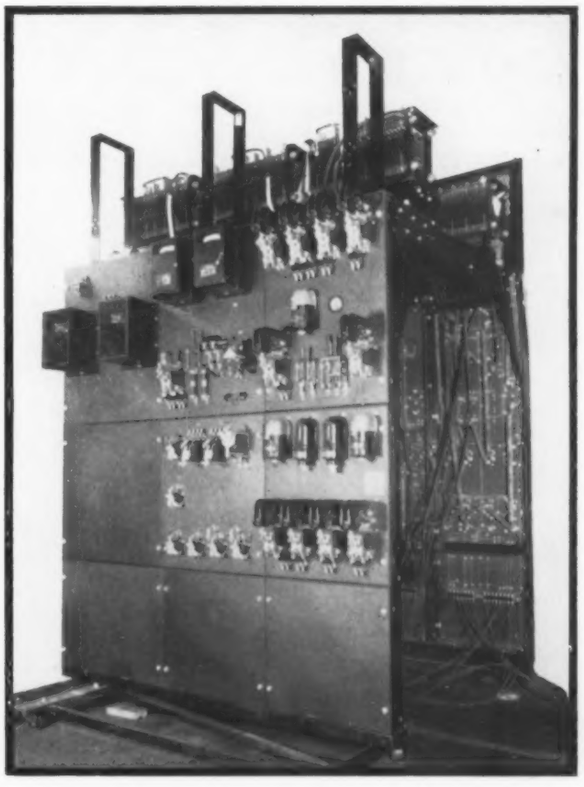


Figure 7 — Factory-assembled screwdown control during construction. When completed, it is ready to set in the mill.



ment intervals in half, it was possible to reduce the rolling time of a slab by 30 seconds or 15 per cent.

Time studies on screwdowns often suggest changes in the mechanical set-up. When the screwdown motor speeds are increased, new problems enter the picture. If the screw pitch exceeds 1½ threads per inch, which is about the limit for a self-locking screw, it becomes necessary to use magnetic brakes to prevent the rolls from backing up. This introduces additional WR^2 which must be accelerated and stopped and it requires some additional time for the brake to release. For roughing mills, time may be saved by using 1½ pitch screws and no brakes in which case the controller should provide dynamic braking. For finishing mills, where the roll settings must be more precise and for larger mills with coarser pitch screws, magnetic brakes are necessary.

With increased screwdown speeds on mills having the top rolls balanced by a hydraulic accumulator, it often becomes necessary to load the accumulator shell with scrap iron to make it, and the top roll, follow the screws in the upward direction. It will then be found to require more power and time to drive the rolls down. If the power to drive down exceeds the power to drive up by more than 50 per cent, some attention should be given to the friction of the hydraulic lines from the mill to the accumulator and the ports to the hydraulic jacks. With less loss due to hydraulic friction, less differential load is required on the accumulator and the time required for closing the rolls will be decreased. In one installation, the doubling of the port area of the hydraulic jacks alone allowed screwdown motors, which had been overheating, to again run at normal temperatures and at the same time speed up the movements.

The motors for the various roll tables, sideguards, fingers and screwdowns are near enough to one size that it is possible to have one spare control panel in the control room which may be used temporarily to replace any one of the regular panels in order to affect repairs. If each controller is equipped with double throw line and control transfer switches, any motor may be quickly transferred to the spare panel without interrupting operations while the regular panel is inspected or serviced. This permits the maintenance crew to keep the control always in a good operating condition thereby avoiding delays.

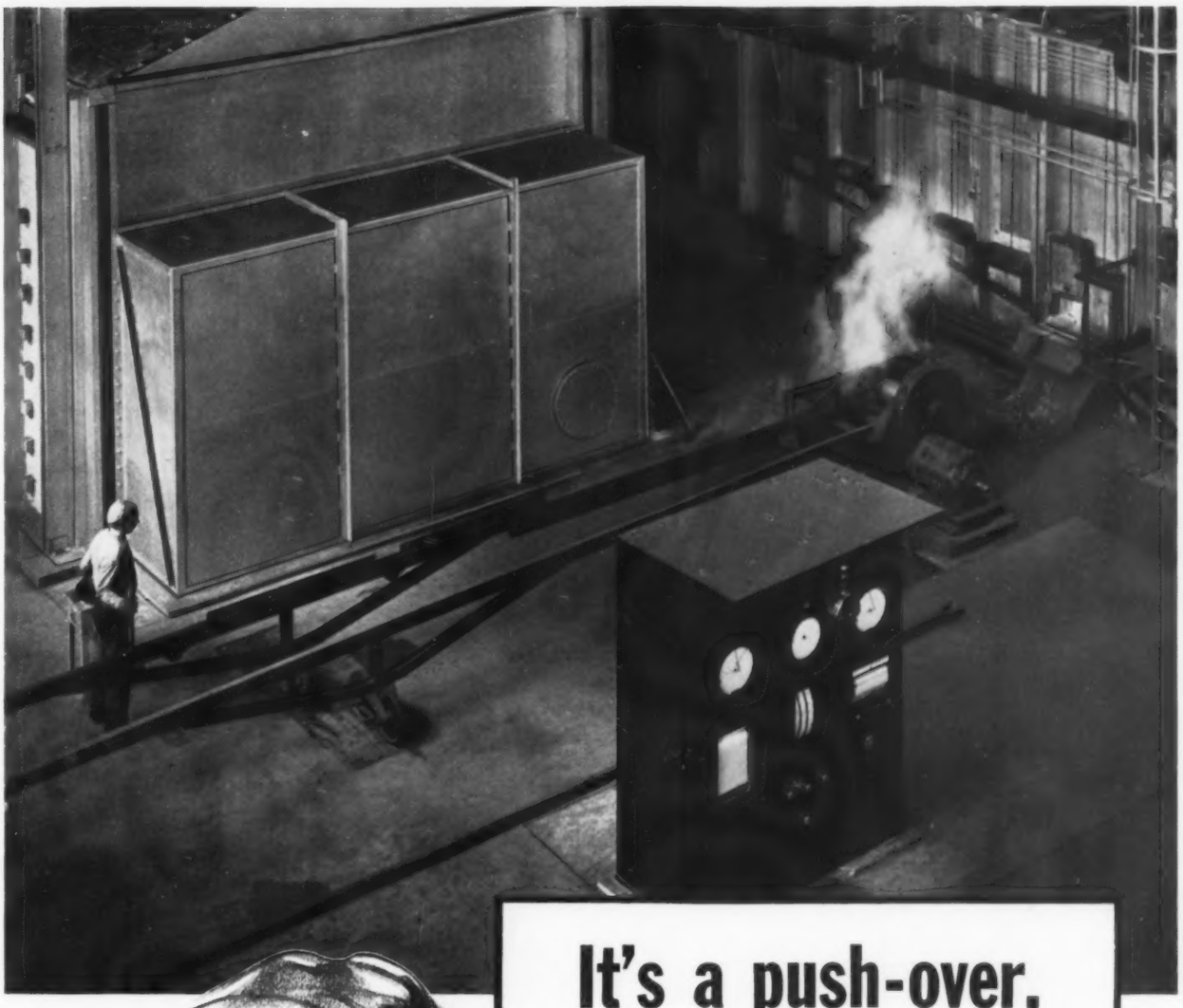
The pre-set screwdown control is probably the most noteworthy addition to the blooming mill or the reversing plate mill. It relieves the mill operator of all the roll setting operations and insures that the proper reductions are taken on all passes. It brings the rolls directly to the proper setting without overshoot or inching. The set-up for the next pass is made automatically when the screwdown stops and requires only the pressing of a button or foot switch to get the desired movement. One operator can control the main roll drive, the roll tables and the screwdown and, as the latter requires so little attention, he is better able to cordinate the reversing of the tables and reversing of the mill.

The pre-set screwdown control has proven extremely valuable where numerous changes in schedules are necessary. It includes a pre-set schedule panel with plugs and jacks for setting up two or more schedules. Figure 4 shows such a panel with plugs and jacks for two schedules. The multi-pole relays at the top are electrically interlocked and it requires only the pressing of the schedule selector push button on the roller's desk to put either schedule into operation. Figure 5 shows the reverse side of this panel with the notching relays that select the passes in proper rotation and operate the pass indicating lights. Shown at the base of the panel are the motor operated face plates and cut-outs which control the stopping of the screwdown motor to agree with the settings.

Figure 6 shows a typical roller's desk. This one includes control for the screws of the edger rolls as well as the horizontal rolls. The palm-operated push buttons initiate the set-ups and operations of the screwdowns while the two rows of lights give a continuous indication of the passes and the schedule. Two productimeters, set flush in the desk, top, give the operator a continuous indication of the roll separation. The desk also provides mounting for various meters and push buttons for oiling systems. Located on either side of the operator are masters for manual operation of the screwdowns and masters for the furnace push-out and the various roll tables.

Figure 7 shows a factory-assembled screwdown control during construction which when finished was complete with resistors, bus bars, and control wiring ready to set in the mill.

In one installation, control of this type was particularly valuable in the rolling of small and varied orders. In fact, the management would save up a mess of small orders for one shift, at which time the office would send out a set-up man with the schedules. While one order was being rolled, the next was being set up. As the last slab of the first order passed through the mill, the first of the next order was coming on the approach table and it was only necessary to push the schedule button to put everything in readiness for the new order. While this was being rolled the set-up was being made for the next. It was unnecessary for the roller to study or memorize the schedule and the correct reduction on each pass resulted in better steel with less delay. This, in my humble opinion, is illustrative of the present trend in d-c control.



It's a push-over, Adolf!...

"Sure . . . I know you had a head start, but you never figured we'd get sore! Well, I'm good-an'-sore . . . and every 20 seconds I push out another billet that's going to keep on rolling until it lands with a bang in Berlin!"

R-108

MORGAN CONSTRUCTION COMPANY • WORCESTER, MASS.

Modern Construction of

▲ THE beginning of European hostilities in the fall of 1939 started an era of plant revisions, expansions, and complete new construction on a scale not seen in this country since World War I. This construction program proceeded under continuously increasing pressure in the race against time.

Even with the vast building program in the steel industry which was associated with the development of the continuous strip mills, steel output soon approached capacity. Thus, changes and improvements to obtain greater capacity were constantly being made.

The steel industry has steadily increased the number of a-c motors used for constant speed drives. Many leading plants have long favored the idea of centralized grouping of a-c control, the same as they install the large d-c auxiliary panels. They have used various expedients for grouping standard a-c starters, not all of which have been entirely satisfactory.

The starters have been mounted on the wall or on building columns. This arrangement definitely limits the number of units that can be grouped, due to the amount of space that is usually available. Other installations have consisted of standard starters on angle iron or pipe frame. These usually require an excessive number of conduit fittings to get the conduits out if the starters are mounted compactly on the framework. Starters are also sometimes grouped on steel panels. This usually requires the difficult and expensive arrangement of bringing the conduits in through the panel and back of the starters.

In an effort to solve this problem at the very start of the large construction program, a new system of a-c control was developed. This development was planned to fulfill the following seven basic requirements:

1. Rugged enough to withstand the demands of continuous 24 hour per day production.
2. Maximum accessibility for quick inspection or maintenance, but with complete safety protection for personnel.
3. Extreme flexibility to obtain any desired combinations of equipment, and still permit additions or rearrangements as required by plant changes.
4. Pre-engineered designs assembled from standard parts to permit determination of space requirements and accurate location of conduits.
5. Compact construction to get the control equipment in the least possible floor space.
6. Delivery to job completely assembled and wired for minimum installation time and effort.
7. Standardization and quantity manufacture to permit competing with the cost of existing types of equipment and installation.

This completely new construction and arrangement

Figure 1 — Standard N. E. M. A. Size 3 fused combination starter.

A-C Motor Control

By F. A. Wright

CUTLER-HAMMER, INC.

MILWAUKEE, WISCONSIN

Presented before A. I. S. E
PITTSBURGH DISTRICT SECTION

. . . . the use of centralized control units offers a number of advantages in a-c motor installations . . . .

of control was christened Unitrol, and made available to the trade about two years ago. The immediate and continuing acceptance has exceeded anything originally anticipated. Installations have been made by leading plants manufacturing steel, aluminum, brass, rubber, fertilizers, chemicals, explosives, paper, petroleum products, soap and beer. A large number of power plant and other specialized applications have been made, with some installations approximating 50 feet in length.

This equipment has been adopted extensively for the many new aluminum and brass processing and fabricating plants constructed during the past year. Many duplicate installations have been made. The new synthetic rubber plants have been almost unanimous in their choice of the new design as the most suitable

Figure 3 — Flush construction of door frame when closed provides attractive appearance.

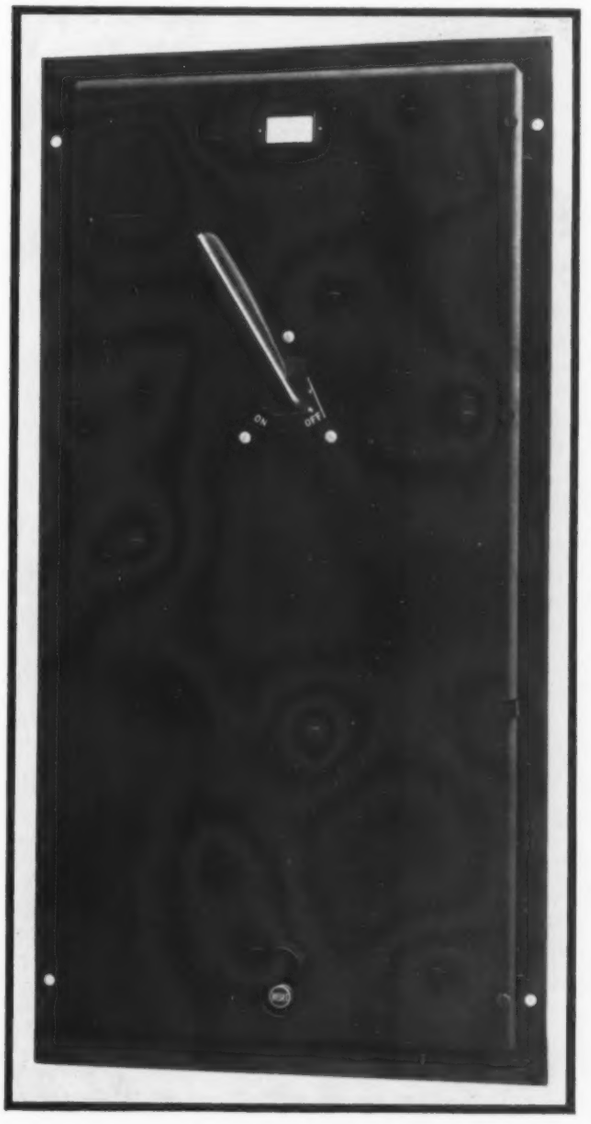
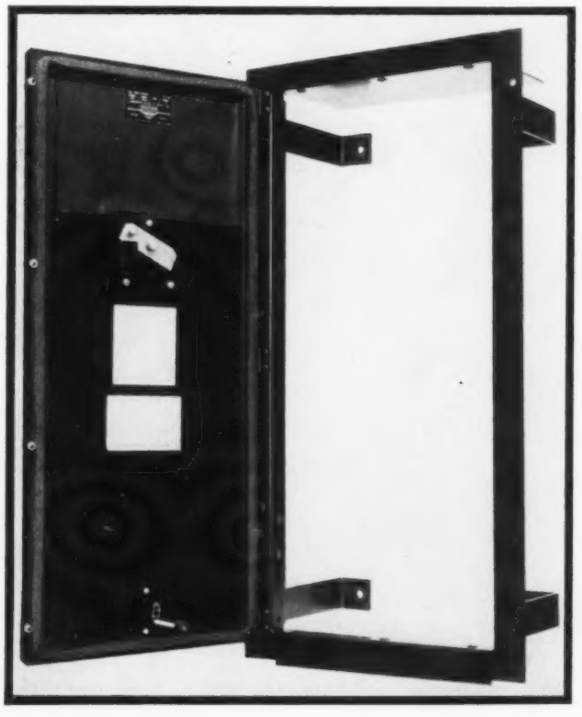


Figure 2 — Door frame used to support controller panels.



method of installing their motor control for the large number of a-c motors required.

The structure is made up of three basic elements:

1. The individual controllers or panels.
2. The supporting enclosures for the panels which are called door frames.
3. The self-standing cubicles or enclosures for the door frames which are called sections. Any combination of two or more sections is called a control center.

A good example of the external appearance of this construction is the sectional steel filing cabinet which is so familiar to all of you.

In the limited time available it is not possible to cover this subject in detail by a word picture so I have selected a few figures in the hope that each picture is worth a thousand words, as stated in the old proverb.

Figure 1 shows a standard fused combination starter exactly the same as would be furnished in a standard wall mounting enclosing case. Similar combination starters, either non-fusible, fusible, or with circuit breaker disconnect, in sizes N. E. M. A. 4 and smaller, are available. Comparable ratings of standard across the line starters, without disconnect, both reversing and non-reversing; auto-transformer type magnetic reduced voltage starters, and a complete range of main line disconnect switches and circuit breakers up to 600 ampere are available. Certain types of d-c and other special service panels have also been provided.

Figure 4 — Panel assembled in door frame. Door is fully interlocked with disconnect switch.

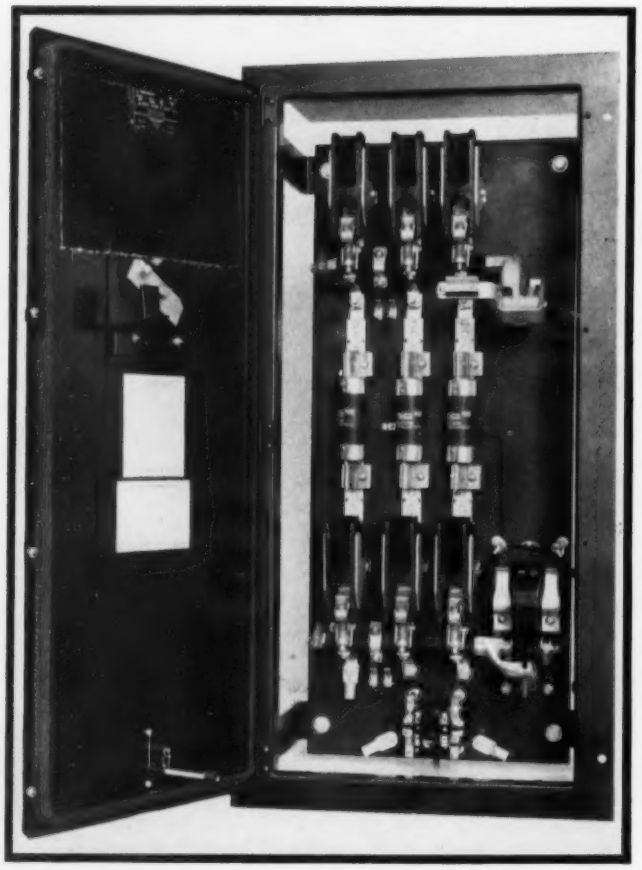
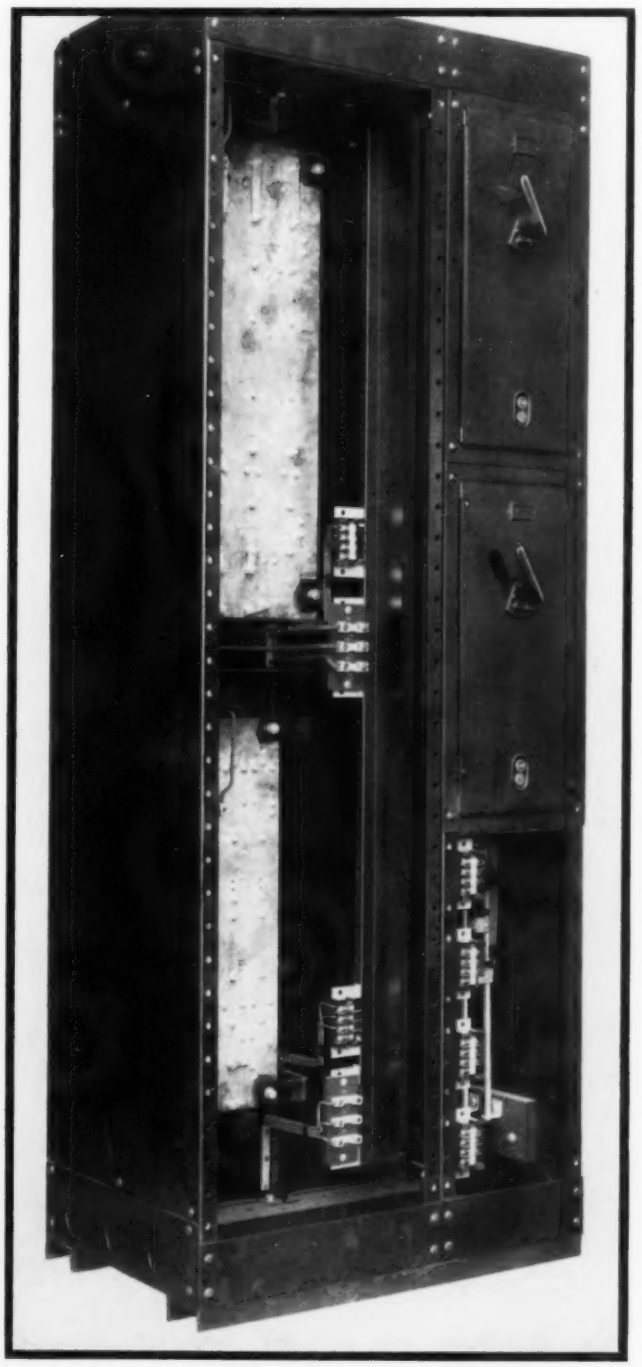


Figure 2 is the door frame used to support the controller panels and form the front of the entire assembly. More than 50 sizes of door frames have been standardized. These range from 12 in. x 12 in. up to 32 in. x 54 in. and can thus accommodate most types of controllers. Note the mounting straps for supporting the panel, also the barrier over the panel for mechanical protection and partial isolation. A heavy felt gasket and angle iron flange assure N. E. M. A. 1A semi-dusttight construction. A cover interlock is provided on all door frames with external dead-front operation of disconnect switches and circuit breakers.

The door is held closed by three or more screws, as

Figure 5 — Interior view showing terminal boards, vertical wiring channel and mechanical details of section.



shown in Figure 3. External overload resets are available if desired, and a card holder for circuit identification is furnished on each door. The beveled edges of the door and the semi-concealed hinges contribute to the attractive appearance. Figure 4 shows how the panel is assembled in door frame. Unusual wiring room and accessibility for inspection and maintenance is provided.

The assembled panel and door frame are then mounted into the supporting cubicle enclosure which is called a section. These sections are available in eight widths from 12 in. to 32 in. and in overall heights of 66 in., 72 in., 84 in. and 90 in., depending upon the wiring facilities provided.

You will note in Figure 5 the flanged edges of the side members of the section are punched on 2 in. centers to permit mounting any height door frame. Each section is always complete in itself, and there is a double wall between adjacent sections. The side members are notched out a depth of 6 in. at top and bottom to permit bus bars and other wiring to pass between sections. Any portion of a section not filled by door frames is covered by blank steel plates. Any desired number of sections can be assembled into a single control center. The sections can be grouped in one or more straight lines, with starters on one or both sides, in an L shape or U shape. Sections may be added or removed quite readily.

Internal wiring facilities include main horizontal bus to distribute power between sections, vertical bus in each section for line feed to each starter. Horizontal and vertical wiring troughs for outgoing wires to motors and pushbutton stations are provided. Complete terminal boards are available for these outgoing wires if desired. In addition to the open bottom for stubbing up conduits from the floor slab, a wide assortment of concentric knockouts is provided in the top and end plates.

The main horizontal bus consists of copper bars up to a maximum of two 4 in. x ¼ in. in parallel supported by a casting specially designed to obtain ease of installation, maximum rigidity, and a good electrical connection to the individual vertical bus bars. The vertical bus consists of three ½ in. diameter copper rods supported on ebony asbestos lumber spacers, and threaded and locked into the supports for the horizontal bus. A special clamp type pressure connector is provided for the line connections between each starter and the vertical bus.

Three styles of construction are offered, the only

Figure 6 — Close-up of vertical and horizontal bus bars with special supports and terminal clamps.

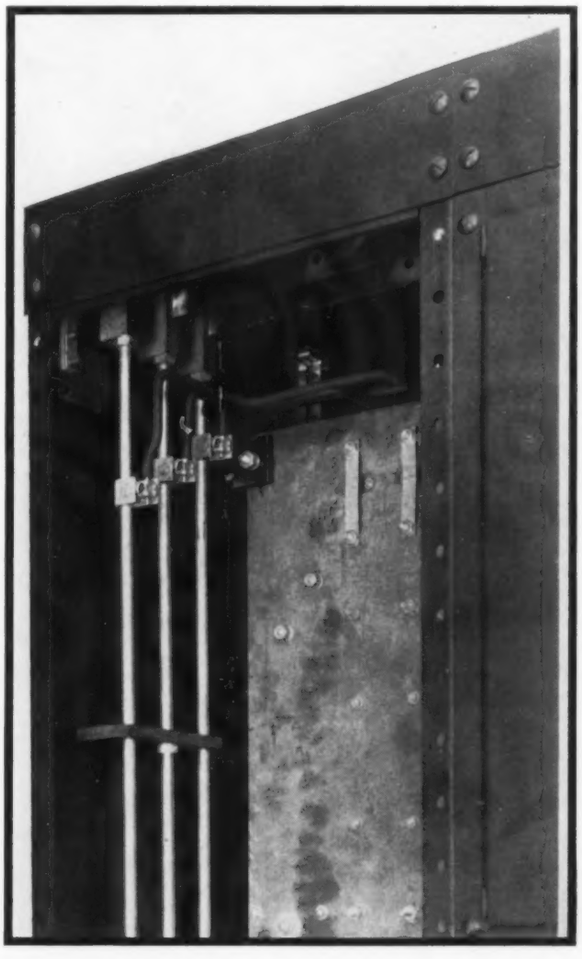
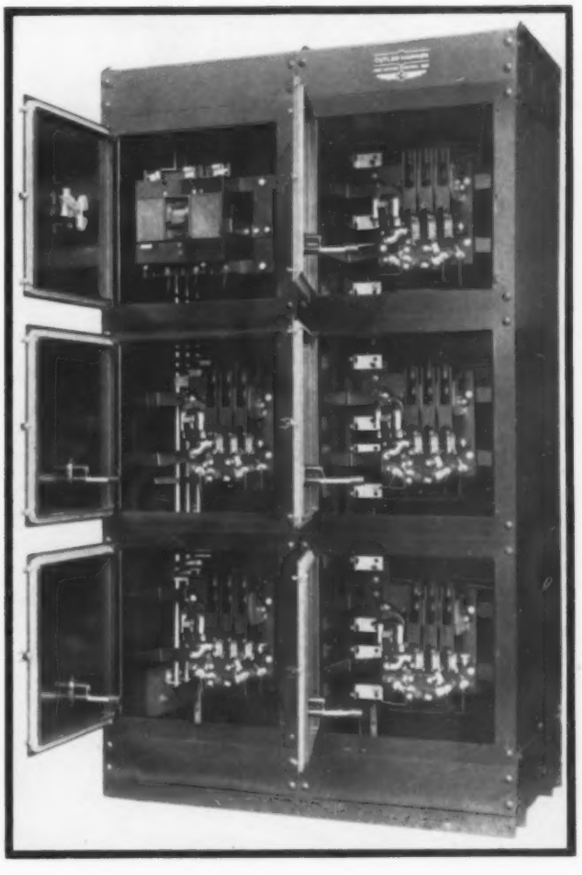


Figure 7 — Unusual space for wiring and inspection is provided in this typical steel plant installation.



difference being the extent of internal wiring. Style A includes only the units mounted in the sections, without any busses or connections; style B includes horizontal and vertical busses with line connections between vertical busses and individual starters; style C in addition includes complete terminal boards for all outgoing load and pushbutton circuit wires, with all connections between the individual starters and these terminal boards.

The completely wired style C construction has been by far the most popular, accounting for 90 per cent of all installations which have been made. The style B represents 7 per cent while only the remaining 3 per cent have been made in the unwired style A. In addition to these complete installations, a large number of individual door frames with control panels have been used for flush mounting the control equipment in the base cavity of a wide variety of machine tools. This, of course, contributes to the streamline effect which is so much a part of all new machine tools.

It may be of interest to elaborate somewhat upon the features contemplated in the original design. Previous experience had established that existing designs of standard starters and special panels were adequate for 24 hour service, even on very severe applications, if they were provided with protective enclosures suitable for the installation conditions. The entire structure is designed to N. E. M. A. 1-A semi-dust-tight standards. These standards meet the requirements of most mill conditions.

This construction encourages and facilitates regular inspection and maintenance by having all controllers grouped, and away from the machine or process work. Opening the door gives good access to the panel for routine inspection or minor maintenance. It is also quite convenient to remove the complete door frame for a major repair or replacement job.

Flexibility is probably the most highly developed single feature of this construction. The four section heights, more than 50 sizes of door frames, and the very wide selection of controllers which have been standardized, all contribute to the flexibility. It is always possible to install additional starters in place of blank plates provided originally, and it is equally simple to add one or more sections. The availability of all parts from large quantity lot manufacture to assemble any combination, further emphasizes the advantage of this flexibility.

For the first time, standardization makes it possible to lay out complete dimensions of the entire control center, with absolute accuracy, before the equipment is ordered. This eliminates the usual delay in obtaining certified drawings from the factory, after a special design is made on each individual order. In many cases this feature makes possible important time savings in the building program. It is also a very important contribution to the war effort because of saving the time and effort of design engineers and draftsmen who are in great demand.

Determining the size of the control room or space, as well as the location of conduits, becomes a simple operation in architectural mathematics, and available data permit you to make your own complete layouts.

This new development is compact, in addition to being flexible. On certain jobs where a detailed analysis was made, it was possible with the back-to-back mounting, to get twice as many starters in a given space, as was possible with older and less flexible methods of installation.

Many large plants have grouped standard starters into control centers for several years. This required considerable layout work, single lot fabrication of supporting framework or panels, and finally mounting and wiring the individual starters. It is much more simple and convenient to merely set the complete new unit in place, on its own channel sills, and connect line, load and control leads.

Most people are favorably impressed with all the features provided in this construction, but many anticipate that the cost may be excessive. A detailed analysis of several typical units, as compared to a similar quantity of standard wall mounting starters, shows that the style A costs only about 50 per cent more than the standard starters, the style B about 65 per cent more and the style C approximately 85 per cent more. A similar analysis of installed costs was made in cooperation with a customer who kept accurate cost records on the old style angle iron frame work mounting. This disclosed that the installed cost of the complete unit varied from 90 to 110 per cent of the old construction and averaged just about an equal cost. This customer feels that the many features of the new development make it a bargain at a comparable price, and they have purchased several very large installations for a number of different plants.

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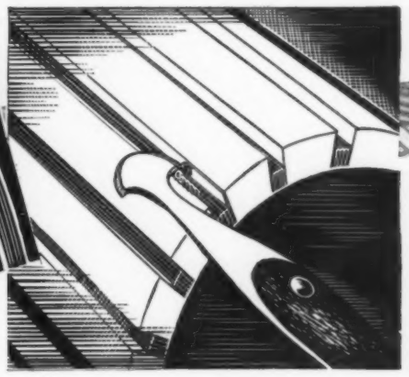
Cleanliness is of paramount importance in the continuous operation of brush-using equipment. Time spent on keeping commutators, rings, brush holders and rigging free from dust, dirt, oil and film pays dividends. Use a suitable canvas wiper frequently on commutators and rings. Keep them clean and keep them running.



Keep Undercut Commutators Free from Side Mica

Thin edges of mica along the sides of slots of undercut commutators are a frequent source of trouble. Special care should be taken to inspect each slot carefully and to remove all side mica when undercutting commutators. Bad sparking and serious commutator burning can be avoided by observing this precaution.

Keep Brush Pressure Uniform and Correct

The spring pressure applied to brushes has a marked influence on brush performance. Equal distribution of current among all brushes requires that the pressure on all brushes be kept as nearly equal as possible. Check brush pressure frequently and adjust it to compensate for brush wear. Use pressures recommended for the grade of brush and class of service in which it is used.

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Low Voltage DISTRIBUTION

▲ THE essential qualifications or any electric distribution system can be classified in the following main divisions:

1. Sufficient available capacity for any normal or expected abnormal load demand.
2. Reliability under fault conditions so that the desired continuity of service is obtained.
3. Low maintenance cost and accessibility for rapid repair or replacement.
4. A first cost in keeping with the degree to which items 1 to 3 are desired and obtained.

In order to systematically and properly analyze these qualifications, each will be discussed separately.

Sufficient available power for a low voltage distribution system calls for transformer capacity adequate to supply the system and conductors large enough to carry the current to the load. In selecting these items, not only current carrying capacity from a thermal standpoint should be considered, but also the ability to maintain a correct voltage level throughout the system under all load conditions. Also there should be sufficient "stiffness" to the system to allow across-the-line starting of motors of medium size without objectionable system voltage dip. The per cent impedance of the high voltage system up to the primary of the transformers, impedance of the transformers themselves and the impedance of busses and cables to the loads are all factors to be considered in keeping the proper voltage level.

In Figure 1 is shown a simple radial system consisting of a 2300 volt supply line, 300 kva transformer bank and radial 440 volt feeders. The 2300 volt system has a short circuit kva of 150,000 which is 500 times the rating of the transformer bank. This is equivalent to .2 per cent impedance on the basis of the 300 kva transformer rating. The transformer has 4 per cent impedance on its own base. The sum of the 2300 volt system and transformer bank impedance is 4.2 per cent. From no load to full load at 80 per cent power factor, the 440 volt bus will have a regulation of approximately 2.52 per cent or 11.1 volts. Knowing the voltage regulation of the 440 volt bus, it is possible to choose cable sizes with a per cent impedance, which is low enough to insure the desired value of voltage at the load. In most cases the impedance of the high tension system is so small it can be neglected. The impedance of the

Figure 1 — Diagram of simple radial a-c distribution system with 2300 volt supply line, 300 kva transformer bank and radial 440 volt feeders.

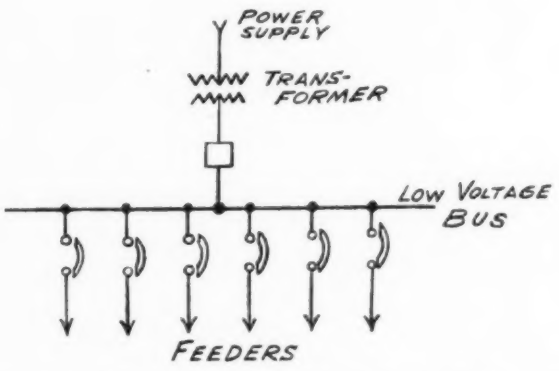
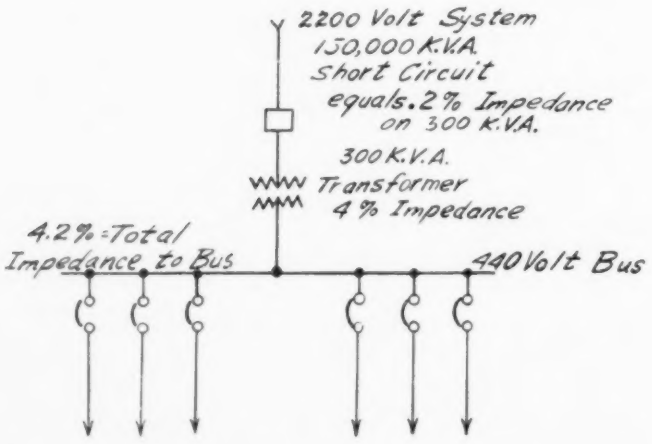
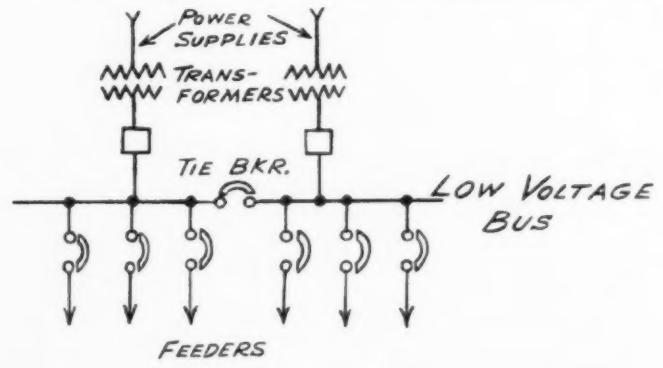


Figure 2 — Two arrangements of 440 volt bus. At top, all power is fed through one transformer bank by one line. Below, a split bus with tie-breaker, with separate transformers and lines.





SYSTEMS *in Steel Mills*

. . . . no particular type of distribution system can be specifically recommended for general steel plant use . . . . performance, continuity of service, and cost should dictate the selection . . . .

By L. L. Fountain

SWITCHGEAR ENGINEERING DEPT.

Westinghouse Electric & Mfg. Co.

EAST PITTSBURGH, PENNA.

Presented before A. I. S. E.
PITTSBURGH DISTRICT SECTION

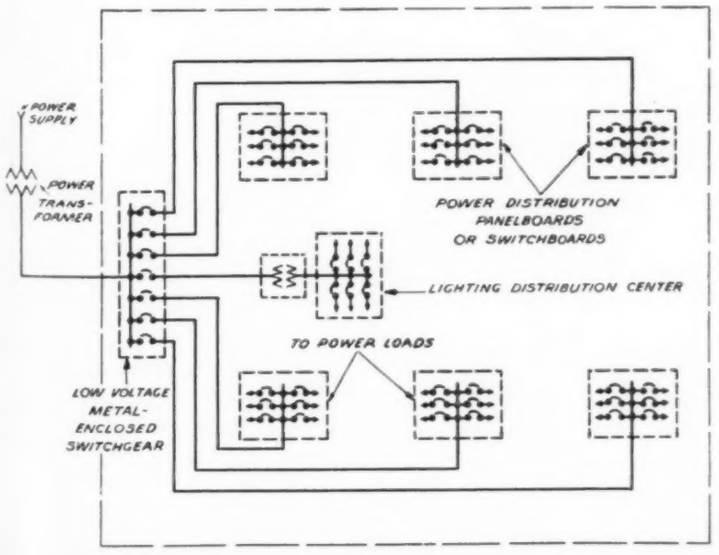
transformer and cables being large in proportion are the cause of most of the voltage regulation. From the standpoint of current rupturing duty on breakers and motor starters, it is desirable to have a limited amount of impedance to hold fault currents within a reasonable value. If more than one motor is fed over the same feeder and some of the motors are to be across-the-line started, then the voltage conditions at the motors with starting inrush currents should be considered. Usually a motor will draw approximately five times its full load current rating on across-the-line starting and therefore the voltage drop between the bus and motor will be five times that at full load.

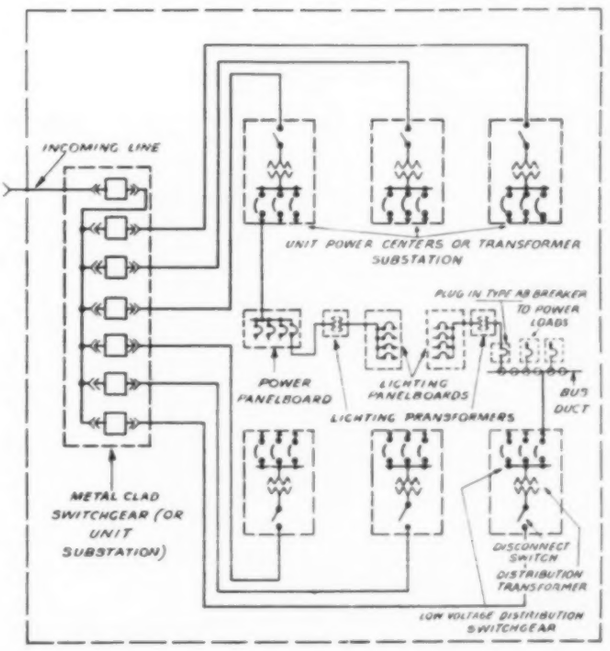
The second qualification, reliability under fault conditions, opens a wide field of consideration and can be overdone as well as neglected to detrimental extent. The best insurance against outages due to improper segregation of faulted portions of the system, is to use equipment on which the probability of faults is least. Certainly metal enclosed switchgear, adequate sized cables or busses and properly protected cable runs will reduce the possibility of faults far more than open gear and cables that run at over-temperature and are not properly protected.

Although precautions of this nature are usually well

Figure 3 — The conventional radial system has lowest first cost, but has disadvantages as to continuity of service and voltage regulation.

Figure 4 — The simple radial system is applicable where loads are heavy or distributed over a large area requiring long feeder runs.





worth while, the economic angle cannot be neglected. When it seems inadvisable to buy the best, there are other precautions that can be taken which will insure a minimum of lost time due to outages. The lumping of vital and essential loads on one feeder should be avoided. Usually a mixture of essential and non-essential loads can be grouped together so that in case of faults the least damage will be felt.

As the system progresses back to the main 440 volt bus and transformer bank it becomes more and more essential to protect against a complete system failure. In Figure 2 are shown two types of 440 volt busses. In the first type all power is fed through one transformer bank by one high tension line. A fault in the transformer or on the high tension line causes a complete power failure. The second type is split by a tie-breaker, each bus being fed by a separate transformer and line. In case of a fault in one transformer it can be quickly removed from service and the tie-breaker closed without appreciable loss of service. Non-essential feeders can be dropped if the total load exceeds the rating of one bank. Usually such an arrangement results in another advantage in that a reduction can be made in the breaker size required to rupture the short circuit currents. In the case of the bus fed by only one large transformer bank, the smallest feeder breaker has to be able to rupture the entire short circuit current at the bus, whereas by splitting the bus, the duty on the feeder breakers is reduced, due to the higher ohms impedance of the small transformer compared with the large one.

The point has now been reached where it might be well to talk about some specific methods of low voltage distribution which put into practice some of the points brought out in the foregoing.

There are two main types of systems, the radial and the network. All other types are modifications of these two. Each has its advantages and disadvantages, but usually, by taking into consideration all factors involved it is easy to determine which to use.

The conventional radial system (Figure 3) is the cheapest to install from the standpoint of first cost but has disadvantages from the standpoint of continuity of service and voltage regulation. Also, if the system is expected to expand in the future, the addition of new feeder breakers and cables will be necessary. If this has not been considered in the original transformer installation a new transformer will be required, which usually leaves a sizeable block of unused capacity.

If the load to be fed involves only a few feeders, considered non-essential in character and will be fixed for this location, then a conventional radial system would probably be the best choice. Careful checking of voltage regulation at the end of feeders and installation of sufficient copper are still important considerations however.

The difference between the simple radial system (Figure 4) and the "conventional system," is that the power is taken nearer to the load over high tension radial feeders before stepping down through the transformer banks to the low voltage distribution. There is a distinct saving in copper and the voltage regulation is not such a problem in this type of system. On the other hand a larger number of transformers of smaller capacity are required which increases the cost per kva. The continuity of service feature is improved since the loss of a transformer or high-tension feeder only involves a small block of load. The loss of the high tension supply line of course interrupts all loads feeding from the high tension bus. In some instances it might be permissible to omit the high tension feeder breakers if the savings will warrant the possibility of the loss of all other feeders in case of a high tension fault.

The low voltage breakers can be of smaller interrupting rating due to the smaller transformer banks, which is a distinct saving in first cost of the overall installation. Additions to systems of this type involve addition of high-tension switchgear and are therefore expensive.

This type of system is applicable where the loads are heavy or distributed over a large area requiring long feeder runs. The cost will often be less than the conventional radial system especially if the high tension feeder breakers are omitted.

The primary selective system (Figure 5) is similar to the one just described except no high-tension switchgear is used for the feeders. The cost is thereby greatly reduced and at the same time it is possible to take the high voltage close to the loads.

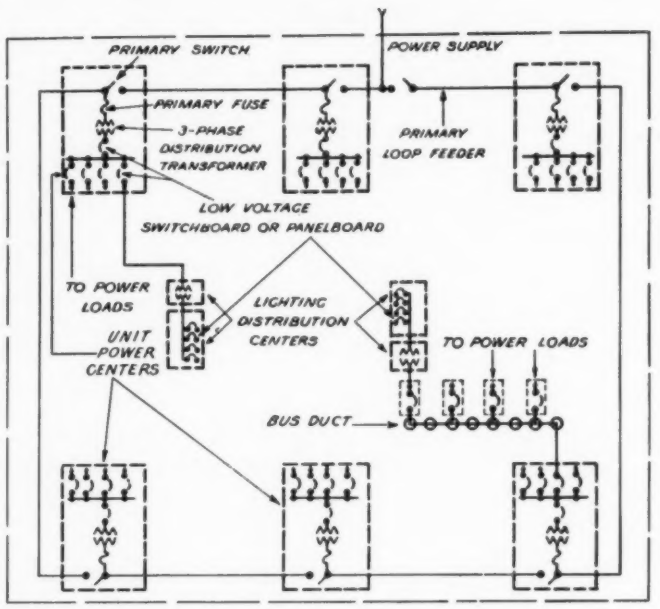


Figure 5 — The primary selective system is similar to the simple radial system of Figure 4, but is lower in cost because of omission of high-tension switchgear for feeders.

The high tension loop does have more exposure to fault possibilities than any one feeder in the simple radial system. A fault on the high tension loop requires the opening of the high tension breaker, which of course causes a complete loss of load. The fault can be quickly isolated however by opening the loop disconnects and the load of all but one transformer picked up again while the trouble is being corrected.

A faulty transformer will blow its fuse and only the radial low tension load being fed by it will be lost. Low tension feeder faults are of course cleared by the low

tension breakers without interruption to the rest of the loop load.

Since any part of the selective loop must be able to carry the entire load, a higher current carrying capacity will be required than on the feeders of the high tension radial system. It might even be economical to go to a higher voltage for this type of system in order to stay within reasonable conductor sizes and keep the voltage regulation down to a reasonable value.

This type of system is suitable for large plants, where long feeder runs would be required in a conventional radial system. It is reasonable in cost but is not all that could be desired from the standpoint of continuity of service, especially where high tension faults are concerned.

The primary and secondary selective radial system (Figure 6) differs from the preceding in that the secondary system is also tied together through a loop. This makes it possible for any transformer to be out of service without interrupting any of the load circuits. The voltage regulation of this system is uniform throughout and of less magnitude than a radial secondary system.

The secondary loop consists of two or more parallel conductors per phase, connected together at load tap busses through limiters. A limiter is copper link, completely enclosed in a tube. The purpose is to protect the cable to which it is connected under short circuit conditions. Should the current through the cable approach short circuit value the link in the limiter will blow, opening the circuit. Being sealed in an insulated tube no fire or smoke is visible. The limiters have a fusing point about 3 to 3½ times the rating of the cable; therefore they are in no sense overload protectors. They do however adequately detect a faulted cable and isolate it from the rest of the system

The use of parallel cables around the loop is necessary in order to obtain selectivity between limiters when a cable is faulted. Cables should be limited to 600 MCM and as many parallel three phase circuits used as necessary. Two small cables in parallel offer less impedance than one large cable. Also from the standpoint of installed cost two small cables will be found more economical.

Considering two cables in parallel around the loop, a fault on one will draw short circuit current over the two cables at each of its ends. The limiters then in the other cables only carry a maximum of one-half the current that flows through the limiters in the faulted cable. This gives proper selection of the faulted cable and leaves the system intact.

The advantages of this type of system are flexibility in making additions to accommodate load growth, small voltage regulation permitting across-the-line starting of motors on the same bus with lighting transformers and high grade continuity of service, due to isolation of secondary faults by limiters without loss of load. It requires a minimum of transformer capacity because advantage can be taken of diversity between loads.

The cost is slightly higher than the radial feeder with loop primary system and rupturing duty on breakers may be higher.

This type of system lends itself to a quick change over to the network system which will be discussed next. Such a change might be desired after a system has been in service for sometime due to increased load and the availability of a second high tension source of power.

The Secondary Network System

The secondary loop of this system is the same as the one just described. The difference in the two systems is in the use of two primary feeders, each normally feeding half of the transformer banks and network protectors to disconnect a faulty primary feeder.

A network protector is a specially designed a-c motor closed and a-c shunt tripped air circuit breaker controlled by network relays. The network relays function to automatically close the breaker only when voltage and phase angle conditions are such that its associated transformer will supply load to the secondary loop and to automatically open the breaker when power flows from the secondary loop to the network transformer.

In case of a primary fault the network relays trip the network protectors on all the transformer banks fed by that high tension circuit. This puts all of the load on the good high tension circuit and its transformer banks. If the system is operating at full load, these transformer banks will of course be overloaded. The double throw changeover switch on the primary of each bank offers a means of quickly connecting the banks on the faulted circuit to the other circuit before the overloaded transformers are harmed.

These double throw switches must be capable of opening the exciting current of the transformer bank to which they are connected. To reestablish the system after the faulted high tension feeder has been repaired, the network protectors are opened one at a time and the double throw switch closed in the proper direction. Interlocking between the network protector and the switch insures the network protector is open which prevents opening of other than transformer exciting current.

A system such as this insures continuity of service to all loads under any type of fault condition, other than one on a secondary feeder and then only its load is interrupted. Voltage regulation is very small allowing larger motors to be started by the across-the-line method without objectionable light flicker due to dips in voltage.

The use of limiters insures isolation of faulty cables anywhere in the secondary loop the same as described in the preceding system.

The D-C Distribution System

Many of the same problems encountered in the design of a low voltage a-c system are also faced in the design of a 250 volt d-c system. The most prominent among these is voltage regulation.

The d-c system has some advantage over the a-c system in that the voltage at the 250 volt d-c generator bus can be controlled by field excitation. In some cases it is advisable to use compound wound generators to get automatic changes in bus voltage to compensate for feeder voltage drops.

The location of motor generator sets near a heavy load center is desirable from the standpoint of voltage

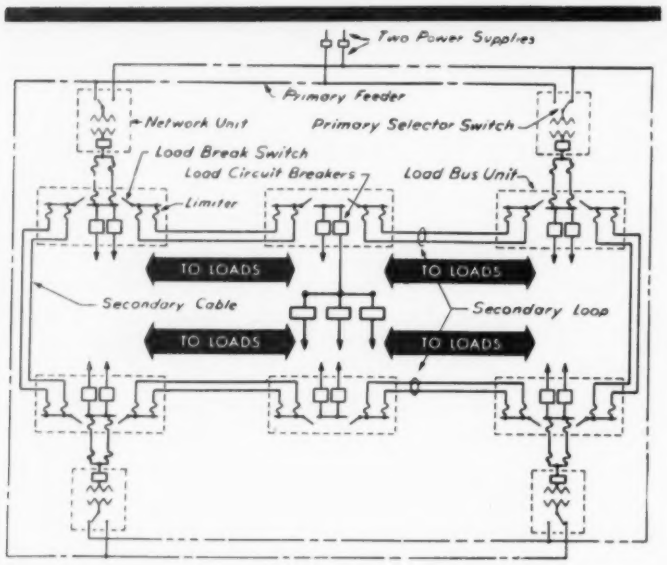
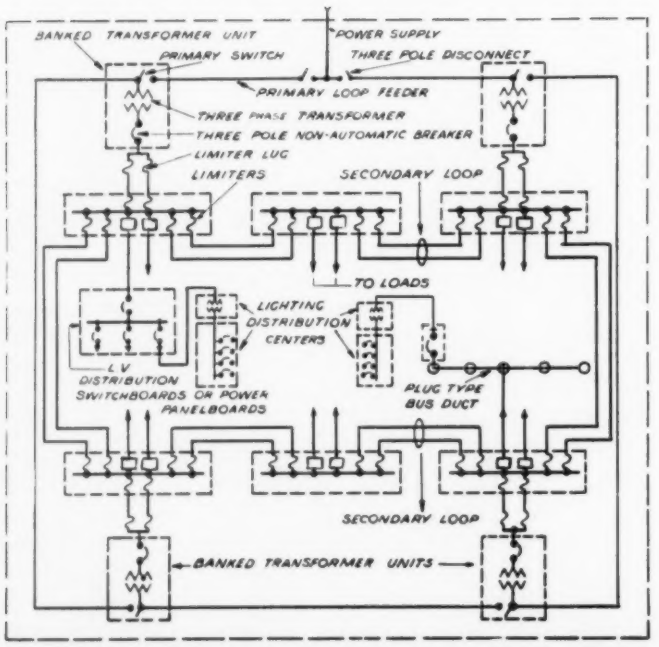


Figure 6 — In the primary and secondary selective radial system, both primary and secondary systems are tied through loops, so that service is uninterrupted by any transformer outage.

regulation but the location is usually dictated by the availability of a-c power for the motor of the set. The mill substations usually have a-c power for 600 volt sets that can be used for 250 volt d-c motor generator sets and consequently this is where most of them are located. Fortunately large blocks of 250 d-c auxiliary power are required in the operation of each mill, which gives the auxiliary 250 volt sets a reasonably close load to carry.

Figure 7 — The secondary loop of the secondary network system is the same as in the system of Figure 6. Two primary feeders are used, however, each normally feeding half of the transformer banks.



The question of whether to use a large motor genera tor set unit or several small ones often arises. If feasible a number of smaller sets is better than one large one, since the failure of one does not cause a loss of auxiliary power. Then, too, in light load periods some of them can be shut down, either as an economic measure or for maintenance purposes. The existence of tie lines with other substations may influence this to some extent.

The subject of tie lines between substations is an important one and requires a great deal of care in designing a satisfactory system. Usually the question of the amount of copper to put in the substation ties arises. The answer to this, depends on the amount of power that is expected to be interchanged between stations and the voltage difference that can be stood between station busses without there being objectionable voltage conditions for local loads.

Under fault conditions it should be possible to automatically open the tie breakers to segregate the faulted portion of the system from the rest. This will keep to a minimum the amount of equipment shut down during a fault. Star points in systems, where several generator or load busses are tied together at a common junction point, should be avoided. Usually a fault at such a point will cause a complete shut down, since there is no way to isolate the fault. This is particularly true, where loads are tapped off of tie line cables.

The modern switchgear equipment available for low voltage a-c systems is also available for d-c 250 volt systems. There are the same advantages obtained by the use of metal clad equipment in reducing maintenance cost and protecting the apparatus from mill dust. Draw-out as well as fixed air breakers of the same design as used in the low voltage a-c system, are recommended, in capacities up to 10,000 amperes d-c.

The use of similar types of equipment for a-c and d-c systems gives a uniformity of appearance where both are located in the same substation. Also, the operating personnel has a smaller diversity of mechanical parts to know and maintain.

Conclusion

It is realized, no particular type of system can be specifically recommended for general steel mill use but that most probably there are applications for all of those mentioned. Their qualifications from the standpoints of performance, continuity of service and cost, should dictate where each is to be applied.

The question of maintenance certainly plays an impostant part in choosing the type of equipment that is to be used in building up any type of distribution system. In steel mills, especially where ore dust, iron oxide, etc., settles on all exposed parts, the use of metal clad equipment would seem logical. The reduction in cleaning maintenance alone, made possible by the use of metal enclosed equipment, should cause a material saving in operating cost.

Metal clad gear has been used in steel mills for some time, especially in the high tension equipment and more recently its popularity has extended to the low voltage distribution system. Manufacturers have gone to quite some effort to develop a dependable and economical line of apparatus to meet the electrical and mechanical

needs of the modern steel mill low voltage distribution system.

Air breakers of adequate rupturing ability are available for use in any part of the system. The "draw out" type of breaker is in great favor since it makes possible the use of a spare breaker while routine or special maintenance is being performed.

Flame and explosion proof transformers are available for use within the mill, which in conjunction with the network protector form a dependable and safe means of feeding the network type of system.

DISCUSSION

PRESENTED BY

G. E. STOLTZ, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

H. L. WILCOX, Assistant Chief Engineer, Electric Controller and Manufacturing Company, Cleveland, Ohio

L. L. FOUNTAIN, Switchgear Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

E. L. ANDERSON, Superintendent, Electrical Department, Bethlehem Steel Company, Johnstown, Pennsylvania

H. G. BARNETT, Industry Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

B. M. JONES, Planning Engineer, Duquesne Light Company, Pittsburgh, Pennsylvania

G. E. STOLTZ: For a number of years we have applied short circuit protection to higher voltage equipment but it was not until the installation of large hot strip mills that studies were made of short circuit problems on direct current systems. The last phase of this work that we have begun to analyze are low voltage a-c systems. I think it can be said that the low voltage systems often due to their complex nature are more difficult to properly analyze than some high voltage systems.

There will probably be a further trend to smaller transformer units rather than having one or two larger banks. This makes it possible to use lower capacity breakers, and enables us to select a system that will have less outage in case of a fault.

Another trend which is very evident is the use of enclosed switchgear and while the apparatus cost is more the installed cost is about the same. The enclosed switchgear of course affords greater protection to the operators and against dirt.

H. L. WILCOX: There are possibly a half dozen types of distribution possible in both high and low voltage systems. There must be certain advantages or good reasons for selecting one over the rest. How would you know which system, such as radial, loop or double loop, is best suited to your plant or installation?

L. L. FOUNTAIN: The type of system to use will depend on the character of the load, and the amount of money that is economically proper to put into it. For certain non-essential loads, it is probably better to use low voltage feeders to the load, eliminating expensive high tension switch gear. There are so many different applications in steel mills it is impossible to definitely specify one type of system to apply to them. In general one of the types mentioned will be found applicable after proper analysis has been given the problem.

E. L. ANDERSON: In connection with the dual loop system as shown in one of the figures by Mr. Fountain, I notice that the connection between the transformer primary and the high voltage loops is made through disconnecting switches, which are indicated as being of air break type. I would like to ask Mr. Fountain if this is an air break switch, and if so, what type switch it is, and how it is arranged to handle the exciting current of the transformer banks should it be necessary to take a bank out of service for inspection and repairs, or to transfer from one loop to the other with both primary loops hot.

H. G. BARNETT: As I understand it your question refers to the double loop or banked secondary system having a primary loop as well as a secondary loop. If the system can be de-energized while a primary cable section is being sectionalized the high-voltage sectionalizing switch can be any suitably insulated disconnecting switch. If the system must be further refined so that the primary sectionalizing has to be done without interrupting service, for example when a transformer is to be inspected, the sectionalizing switch must be a load break switch. There are air-break switches for that type of service.

B. M. JONES: This paper describes very well a network system for rendering service to industrial plants that require a very high degree of continuity. For continuity of service, a network renders the most nearly continuous service, exceeding the degree of continuity of service rendered from radial systems.

The material advantages of such a network are the improved voltage regulation and the small increment cost of additions to the network at the required locations. Everybody wants to get away from motor starters and would like to start motors across the line, and such a network permits starting much larger motors across the line, than a radial type of system, but, of course, there is some limit to the size of motor that can be started across the line.

The network principle is old, as we all know. The old Edison d-c network was the earliest, and the low voltage a-c network was developed later, coming into general use about 15 to 18 years ago, and has been used in an increasing number of cities since. The principle of all low voltage a-c networks of utility companies is to hang onto the faults and burn them off, rather than have breakers or fuses trip out in case of network faults.

I am very glad to see that the industries are beginning to look with favor on networks for distribution within their plants, for in this day and age continuity of service is becoming more and more important. Interruptions just are not tolerated anymore if the electrical depart-

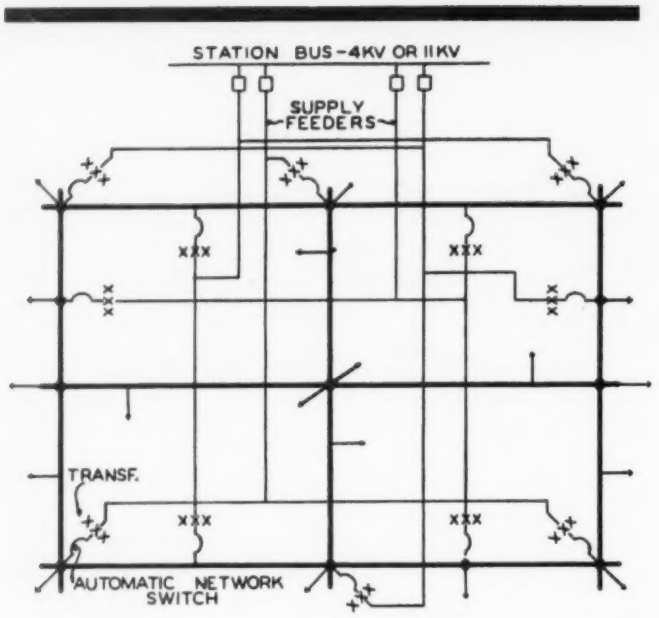
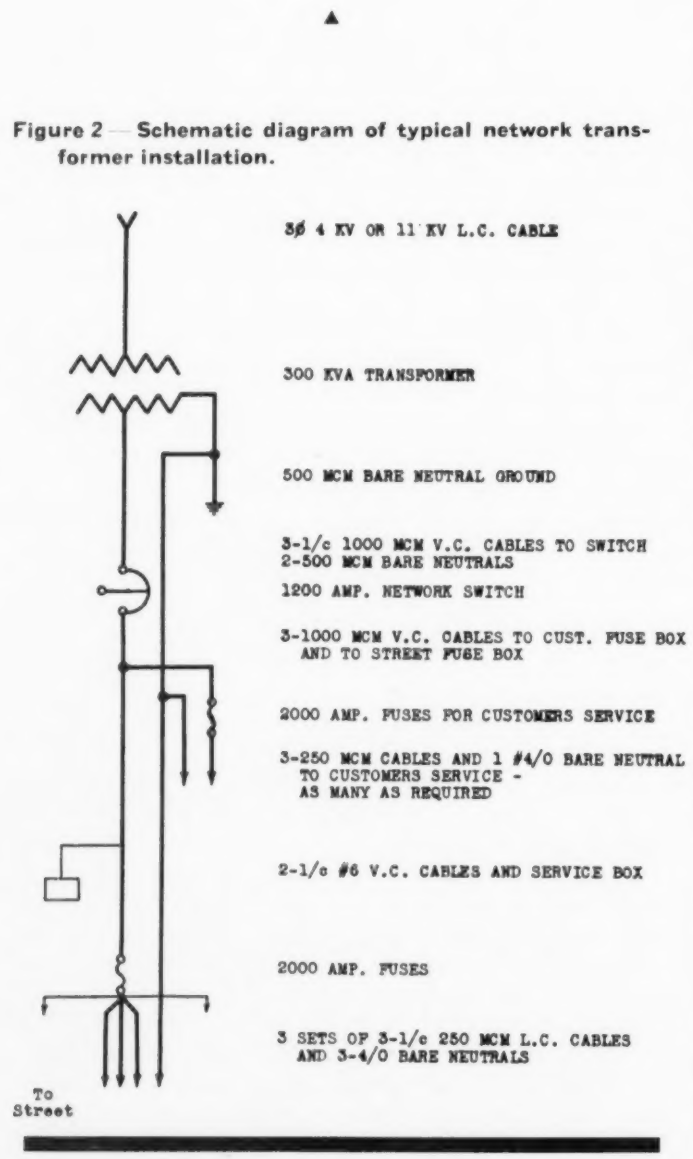


Figure 1 — The automatic network switch is a carbon circuit breaker with reverse power tripping only.

▲

Figure 2 — Schematic diagram of typical network transformer installation.


3ø 4 KV OR 11 KV L.C. CABLE
300 KVA TRANSFORMER
500 MCM BARE NEUTRAL GROUND
3-1/c 1000 MCM V.C. CABLES TO SWITCH
2-500 MCM BARE NEUTRALS
1200 AMP. NETWORK SWITCH
3-1000 MCM V.C. CABLES TO CUST. FUSE BOX AND TO STREET FUSE BOX
2000 AMP. FUSES FOR CUSTOMERS SERVICE
3-250 MCM CABLES AND 1 #4/0 BARE NEUTRAL TO CUSTOMERS SERVICE - AS MANY AS REQUIRED
2-1/c #6 V.C. CABLES AND SERVICE BOX
2000 AMP. FUSES
3 SETS OF 3-1/c 250 MCM L.C. CABLES AND 3-4/0 BARE NEUTRALS
To Street

ment can prevent them at anywhere near a reasonable cost, particularly in war times when we must keep everything rolling that can be turned over.

We in the Duquesne Light Company advocate a-c networks where they are justified, and now have two on our system: one, a 115/199 volt, 3-phase, 4-wire network in the downtown business section of the city of Pittsburgh; the other a 3-phase, 4-wire, 4 kv distribution network in the Verona-Oakmont district. The former has been in service since about 1927, and the latter since 1930 or 1931. A few comments on the 115/199 volt network are given below, as that is comparable to the network described by Mr. Fountain.

The downtown low tension a-c network is a 115/199 volt, 3-phase, 4-wire syst m, with the lighting taken from phase wires to neutral, and the power from phase to phase. In some cases, a booster is required to furnish 220 volt power where needed.

In a utility distribution system, the networks are used where there is concentration of load requiring very high continuity of service and, in some cases, where street space is at a premium for cables and transformer vaults. The great advantage of any network is the permitting of picking up small blocks of load without making a new substation or transformer installation. In our case, we just connect the small loads onto the street mains through a manhole. The larger loads, of course, require additional transformers at the particular locations. Increments of additional capacity can be installed after the network is established in units closely approximating the load growth.

As a matter of interest, in some of the taller buildings downtown, some of the network transformer installations are on the upper floors. In the Gulf building, there is a vault of two units of 500 kva in the sub-basement, and two units of 300 kva on the 39th floor.

In Figure 1, the automatic network switch is in reality a carbon circuit breaker with reverse power tripping only, and it does not trip for power flowing into the network. The reverse power tripping, of course, cuts this transformer off from the network in case of failure between the network switch and the transformer (a very short distance), within the transformer, and on the high tension supply cable. Naturally, these relays are very sensitive for they will operate when the supply line is opened at the substation or power station.

Figure 2 shows a schematic diagram of a typical network transformer installation. Transformer bank sizes vary from 300 kva to 750 kva, and the secondary connections are reinforced accordingly. Where more than one transformer is required at one location, multiples of this diagram are used and the secondaries are bussed within the vault, and circuits from this bus taken to the street mains. Of course, a different supply cable is used for the different transformers at one location.

We use single conductor, 250 MCM lead covered cable for our street mains, and parallel as many as are required.

The load on this network was about 8,100 kva when it was initially installed in 1927, of course, the load being transferred to it from an old radial distribution system. The 1941 load was 35,900 kva there being 27,900 kva of load on the two low voltage a-c networks supplied at 11 kv, and 8,000 kva of load on the two low voltage a-c networks supplied at 4 kv. In 1940, the

load was 34,000 kva, with 25,600 kva on the two low voltage a-c networks supplied at 11 kv, and 8,400 kva on the low voltage a-c networks supplied at 4 kv.

A considerable portion of this network is in the flood zone, and, of course, submersible equipment is used. For standardization of equipment and reduction of spare part requirements, we now buy all submersible equipment. As a matter of interest, during the March, 1936, flood a considerable portion of this network, including transformers and network switches, operated completely submerged.

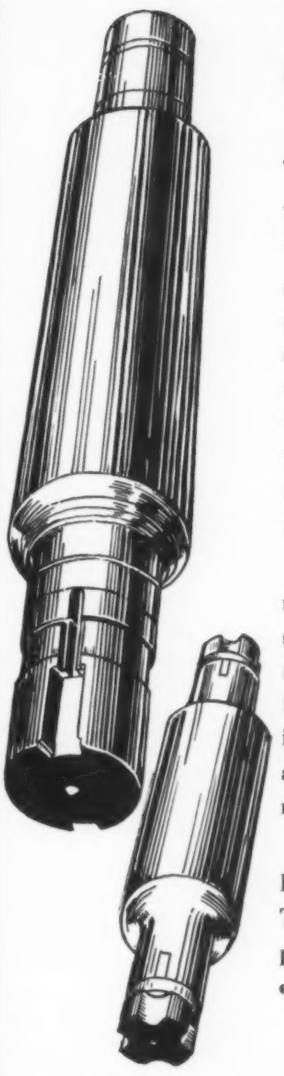
The use of four network feeders with transformers relatively evenly spread over the four, permits the installation of only 25 per cent spare transformer and supply feeder capacity, that is, ¼ of the total. Actually, a failure of one supply feeder takes out of service all transformers connected to it as soon as the feeder breaker trips at the supply substation or power station, and the remaining three feeders with their transformers must, and do, carry the load and render satisfactory service.

While this downtown a-c network system is operated at 115/199 volts, we see no reason why, with the present available equipment (barring priority restrictions), a satisfactory a-c network could not be designed and built for 440 volts and maybe even slightly higher.

H. G. BARNETT: There is the further point that the sectionalizing and load points on a primary loop are generally limited to a rather small number when circuit breakers are used to automatically sectionalize the loop. Otherwise the primary loop for supplying a network system is basically alright. There are two general methods for controlling the operation of the sectionalizing breakers. One is to use differential relaying which requires pilot wires paralleling the primary loop. The other method is to use directional overcurrent relaying which depends on timing for selective operation of the breakers. In the latter case the necessity for timing definitely limits the number of sectionalizing points that can be used in one primary loop; this in turn limits the number of transformer units that can be supplied by a primary loop.

If you consider your own secondary network in the downtown area you will note that there are several radial primary feeders going into the network area and that the network transformers are connected directly to the primary feeders without sectionalizing breakers in the primary circuits. With several primary feeders supplying the same network it is economical to have the relatively small amount of reserve transformer capacity required so that in an emergency when one feeder and its associated transformers are out of service the other three or four feeders can safely carry the total load while the feeder out of service is being restored to normal operation. In most industrial plants not more than two feeders are required to carry the load and provide duplicate sources of supply. It is not economical to provide enough transformer capacity on each feeder to carry the total load when one feeder is out of operation. If the selector switch is used in the network arrangement described by Mr. Fountain the transformers on the de-energized feeder can be switched to the good feeder. This permits using only enough transformer capacity to carry the maximum load with one transformer unit out of operation.

NATIONAL ROLLS



The Hardest Ordeal of Metal

MOST metal parts are used integrally in assemblies and hold merely with *static* strength; but the metals used in NATIONAL ROLLS must be dynamic, and even belligerent in defeating the weaker metals they process.

Everything depends on rigid base of reserve strength, accuracy of machining with metal tough enough to retain its form, and machining and smoothing that remain true in service.

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Rolls & Rolling Mill Equipment
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"Is MAINTENANCE and DESIGN a Partnership?"

By W. J. Fleming

Industrial Control Engineering Department

General Electric Company

SCHENECTADY, NEW YORK

Presented before joint meeting of
PITTSBURGH and CLEVELAND DISTRICTS
at Warren, Ohio

. . . . teamwork between the maintenance man and the designer leads to many improvements in electrical equipment . . . . more effective use of this team is desirable . . . .

▲ THE answer to this question is very definitely yes. The team work of the maintenance man and designer in industry is just as necessary and effective in producing the quantity and quality of products we need as is the team work of the championship ball club in the field of sports, producing the hits and runs needed to beat their opponents.

Each player on the team must be fully acquainted with the other players' duties and part in the game so that they can effectively handle each play with the precision and speed necessary. So must the maintenance and design partnership consult and work together, each contributing its own skill and ingenuity to effectively and speedily produce quantity with the right quality.

The designer must know how to design and build devices, and in addition he must know the application of which each device is a part, the duty cycle required, and since all machinery and apparatus require maintenance, he must know the problems of maintenance so that he can build into his product such simplification and accessibility as are necessary to permit proper maintenance.

This combining of the effort and ingenuity of maintenance and design to design and build into apparatus the accessibility, simplicity and quality necessary to effect the fewest possible shutdowns, must be carried further than in the past.

There is no product built that cannot or does not give some trouble at one time or other. It may be possible to build a product which would never give trouble, but the cost would be too high, the size out of proportion and the maintenance problem complicated.

The manufacturer designs and rates his product with a reasonable margin of safety. Even so a certain number of troubles can be expected. Your suggestions guide the designer in reducing these to a minimum and to improve the product.

Do not be disappointed if an idea is not adopted at once because there are usually other factors involved.

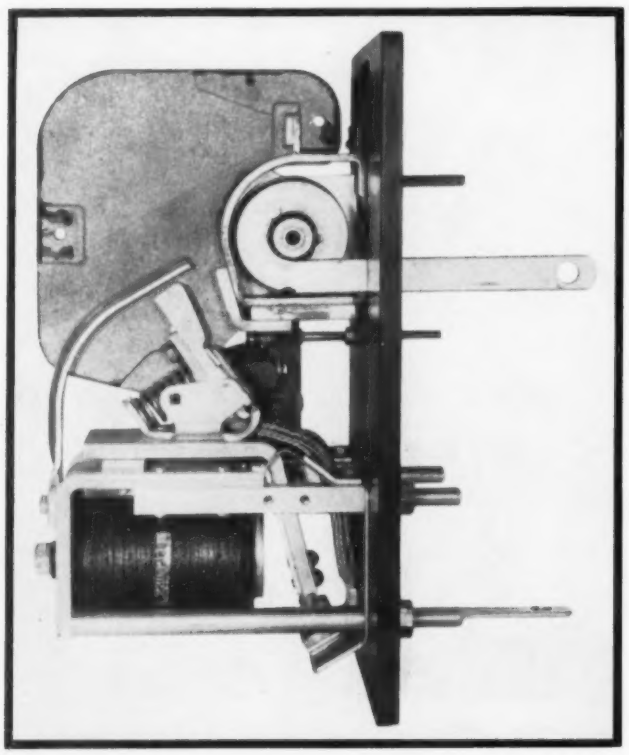


Figure 1 — This d-c contactor has many points suggested by maintenance men, including the bending of the terminal strap so that a wrench will clear the contactor mounted below when removing the shunt, addition of the stop on the movable tip to make for easier replacement of tips, and slotting of stationary tip to permit removal of the tip without removing the tip screw.

Suggestions from one location vary with those from other localities and with operation requirements. It is necessary that the designer select those suggestions which are most representative.

Industrial control has expanded very rapidly during the past ten years. The electrification of more and more machines, and the interlocking of operations for continuous processes — all have contributed to the encouragement of this expansion. The designer, therefore, should and can bring to the maintenance man a sound understanding of the fundamentals of his design and a knowledge of its limitations. It is sometimes dangerous to say, or even infer, that a product has limitations, but that should not be so.

Almost anyone can take the favorable characteristics of materials and make a design, but generally, the result will be only average. True, it will work, but if, on the other hand, he takes the limiting characteristics of a material, product or device and turns these by his ingenuity to an improvement, he has made an advance in the art. American industry has done just this, so today it is recognized as one of our greatest assets.

Industrial control is necessary in each industry where electricity is used and is found in each process in these industries. Let us, therefore, discuss some of the information the designer brings to the maintenance man and see the results accomplished in the design of control by the suggestions of the maintenance man.

Electronics, a new industrial control tool, made possible the electrification of certain operations which were beyond the limits of control contactors, relays and limit switches because of its inherent speed and accuracy. Electronics is not complicated or difficult to understand. Just as in other control, there are certain fundamental principles of operation and design. Many of these are now interpreted into standard circuits. Electronics, however, must not be looked upon as the cure-all for control troubles, but rather as a means of augmenting present control devices.

When the photoelectric relay was first brought out, it was applied to hundreds of jobs for which it was not designed. Therefore, certain troubles were encountered not because of the photo relay, but rather because of the application of these devices to jobs for which they were not intended. Present day designs are suitable for many applications, in fact they are used on many more difficult applications than originally contemplated.

Electronics has permitted control to reach out and electrify those processes where the signals available are of such low energy that they cannot operate contactors and relays. Electronics with contactors and relays have solved this type of problem, such as the width gauge, pin-hole detector and weft straightener.

Industry has looked to the manufacturers for many years for a better means of obtaining speed control. Practically all methods of obtaining speed control whether of the mechanical or electrical type has some limitation. Electronics has provided a new variable speed controller in the thy-mo-trol. The speed range provided with this control is limited only by the motor heating at low speed and the stability of the motor at high speed. With the proper selection of the motor, speed ranges as high as 50:1 have been obtained.

This new control provides the advantages of a variable voltage system of control from a single dial on the push button. Incidentally as a practical thought on the war effort this control requires no a-c motor and generator as does the variable voltage drive, thereby saving in material and manufacturing facilities.

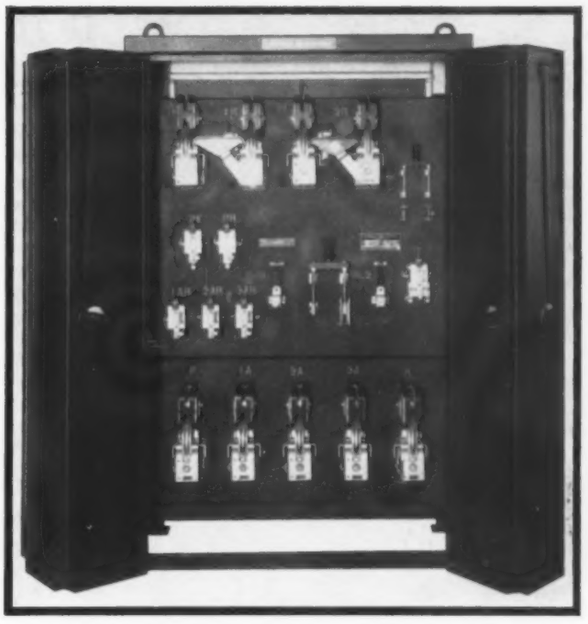


Figure 2 — This crane controller enclosure has folding doors to provide more accessibility on runways. The doors are shown here folded back out of the way.

The speed can be preset or selected during operation, the motor responding quickly and smoothly with full protection to the motor and driven machine. Overload and accelerating peaks are limited to safe values and the motor is stopped by dynamic braking. This development has progressed to date only in the lower hp sizes.

Improved arc interrupting characteristics in contactors were introduced over twenty years ago with the use of blowout coils which acted to build up a magnetic field in such a way that it would force the arc off the tips. This permitted the use of contactors on heavier duties and increased tip life.

Within recent years, there have been modifications and improvements in various uses of blowout construction. Perhaps one of the most pronounced has been the narrowing of the opening in the arc chute which has tended to speed up the movement of the arc, and since speed of movement of the arc has considerable to do with the extinguishing of a d-c arc, this has helped materially.

One other improvement has been the use of arcing horns and arc chutes of larger area which has provided a means of stretching the arc, thus moving it off the tip more rapidly. This keeps the tip cooler and provides longer life.

Research has shown that the best means of extinguishing an arc is by cooling. Therefore, any means such as restricted arc chutes, which tends to force the arc, will increase the tip life on contactors. Tests show that

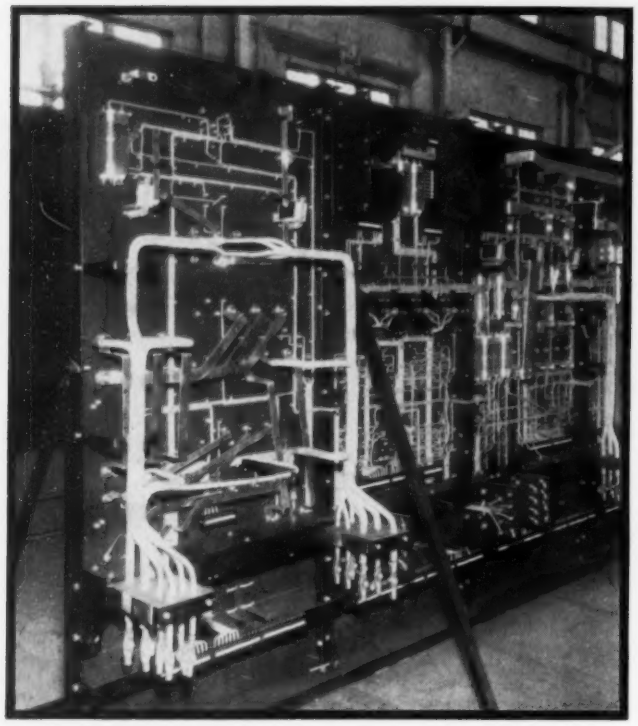


Figure 3 — On this panel power control and field terminals are arranged in separate groups, each conveniently located. Wiring on the panel and the mounting of parts on the back of the panel is arranged for maximum accessibility.

in the more recent designs contact tip life is from two to three times that of previous designs.

It is necessary also that the designer build into his product, for the same cost and size, mechanical life many times that of preceding designs if he is to keep up with the duty requirements of industry and provide low maintenance. It is for this reason that materials different from cast iron are now used for contactor frames and armatures. It is only natural that a large number of manufacturers have gone to rolled steel.

True, there are various methods of construction today, each one having its own merits. Of first importance in the mechanical design of a device is the pivot point which must be designed so that it will withstand numerous pounding actions rather than rotation, since in the average contactor rotation is less than 40 degrees. Therefore, whether the contactor has one type of bearing or another, the pivot point must be designed to withstand repetitive pounding rather than rotation.

D-c contactor magnets have been designed to operate a large number of times, but it is more difficult to design a-c magnets which will give the mechanical life desired.

As you are well aware, it is necessary that a-c magnets be made of laminations riveted together with pole shaders in the face of the magnet. A pole shader provides the magnetism to hold the magnet closed during the period when the current in the main coil goes through zero. If this pull from the shader were not available, the magnet would tend to pound, just as a high speed rivet hammer does, and spread the laminations.

There have been various designs and constructions of a-c magnets. Some of these designs have resulted in very long life. However, shaders and laminations are a possible source of trouble on heavy duty work.

The inrush current of an a-c contactor, varying between 10 and 20 times the holding current, imposes a heavy duty on the contacts of master switches, push buttons and other pilot devices. Some of these currents are in the neighborhood of 75 amperes. During the past several years, a-c contactors for heavy duty have been designed using d-c magnets. The d-c magnet eliminates the use of pole shaders, laminations and the inrush current required by the operating coil is substantially reduced with the result that the mechanical life of the a-c contactor with a d-c magnet is equivalent to that of d-c contactors and the duty on the push button and master switch is very moderate, giving longer tip life.

It is well to note that the use of d-c excitation on an a-c magnet is not satisfactory for rapid duty. The inrush current to pick up the device is maintained during the closing of the magnet, resulting in more pounding and shorter life than with a-c on the magnet.

The designer alone does not take credit for this advance, in fact it is sometimes difficult to tell whether it was the maintenance or the design influence that improved the product.

The trend at the present time is to design devices which are self-contained units. That is, the contacts, armature and magnet are assembled, adjusted and lined up at the factory as a separate unit, which can be mounted self contained rather than as individual parts. This arrangement simplifies replacement and provide for more uniform operation, resulting in longer life. It further simplifies the maintenance problem particularly with regard to the time of replacement of the complete device. The unit needing repair can be taken back to the shop and worked on under better conditions and where facilities and time are available for making the necessary repairs and adjustments.

Whether the application of control be to a main roll drive, an auxiliary or an accessory to the regular production of steel, combinations of control devices are assembled to perform the operation desired. To maintain continuity of service, the devices must be placed on the panel in a logical arrangement. Wiring, bus work, outgoing terminals, resistors, etc., must be mounted and arranged to give the maximum in reliability and accessibility. Therefore, the constructional details of the controller are very important, and offer fertile ground for interchange of ideas between design and maintenance.

Present practice in building controllers for main roll and group auxiliary drives is to provide at a convenient point on the controller, sufficient terminals for making a common junction for all wiring between limit switches, controllers, masters and other auxiliary devices mounted separate from the panel. You know the time saving value of this practice.

Another aid to trouble shooting is the use of a white wire for the positive and a black wire for the negative in the control circuit so that they can be readily distinguishable.

Another detail of this type — and to those not so closely associated with the problem of keeping a mill running as are you, this may seem insignificant, but

it is really important — is the use of a resistor in the field circuit of variable voltage main drives which can be easily adjusted for small changes in resistance necessary during installation or for adjustment to meet the local requirements of the drive.

These features all contribute to maintaining continuity of service. The maintenance man can and does assist the designer in determining the extent to which it is necessary to provide means to help in maintaining continuity of service.

The use of spare controllers, wiring and motors which can be switched into service at a moment's notice, replacing that part causing the stoppage, is desirable in certain installations. The use of an indicating means to show which control of the group of interlocked controls caused the stoppage has been of great assistance in reducing shut down time.

In this connection, you will be interested in an installation of a railroad traffic bridge by one of the major passenger lines. This road figured that a shut-down of 24 hours' duration would cost the road one million dollars in good will. Therefore, this bridge is equipped with four separate sources of power, two single phase and two three phase. There are three driving motors, any two of which will operate the bridge. This is a variable voltage drive, and the driving motors are operated through four motor generator sets, anyone of which will operate the bridge and anyone of the motor generator sets will operate from anyone of the four separate power sources. The bridge is completely interlocked so the tracks must be lined up, the de-railers be in position and the dispatcher's signal show clear before the required operation can be made. As a further guarantee that service should not be interrupted, a gasoline driven engine is mounted on the bridge so that it can be used in case all other means should fail. This, we can say, is the height of protection to insure continuity of service.

Figure 4 — View showing the mounting and arrangement of resistors on control assembled at the factory. Each resistor box can be replaced without disturbing any other box.

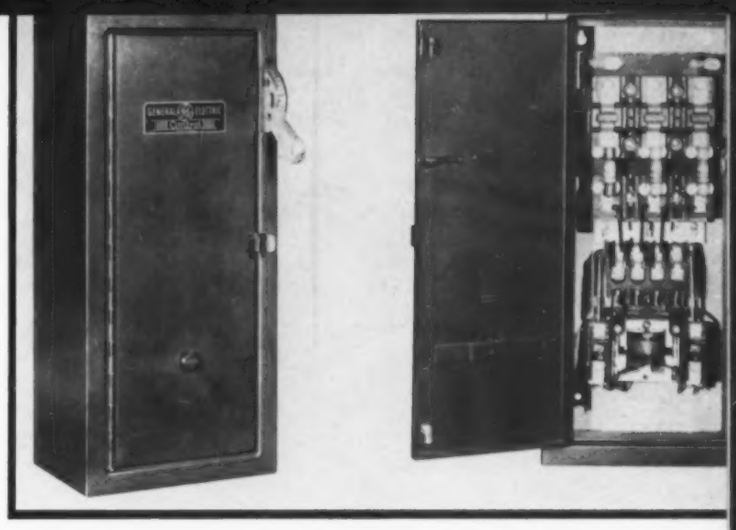


Figure 5 — This a-c across-the-line magnetic switch with main line disconnects and fuses has the disconnect operated from outside the enclosure, and is arranged so that the switch or the starter can be individually removed as a separate unit.

Another important question which the designer of controllers has to face is: "To what extent should the control be made fool-proof?" Naturally, you can build any controller so that no matter what the operator does, the control will respond properly only when the control is operated in the accepted manner. But, if this is done, the additional relays and interlocking would add complications and possible sources of trouble to the control.

In the early days of control acceleration was accomplished by manual means depending upon the operator. This, however, was not considered entirely satisfactory, and it was deemed advisable to provide a means of protecting the motor and drive during acceleration. Control of acceleration by automatic means was provided. This prevented an operator from abusing the motor and drive by rapid movement of the controller handle. Admittedly, this was a step forward and has paid for itself many times.

Another element of fool-proofness, which falls in the same category and which is now considered sound practice, is the plugging protection provided on a magnetic controller so that in case the controller is reversed rapidly, the motion is subjected to automatically controlled amounts of torque for retarding. In the case of cranes, slippage is reduced to a minimum, and in the case of table rolls and other auxiliary drives, the gearing and mechanism are protected against excessive torques.

Another degree of fool-proofness, which pays dividends and is cheap insurance, is better protection of drives which operate expensive machinery such as heavy furnaces, wherein the door is operated automatically and stopped at the extremes of motion by limit switches. Here, the addition of two devices in the motor circuit, operated by the limit switches so that both are de-energized at the same time, allows for an abnormal condition which would cause one of the devices to stick

but permit the opening of the other. In this case, the addition of perhaps fifty dollars of control and protective wiring would save a thousand or ten thousand dollar furnace from being damaged. This, again, is sound protection.

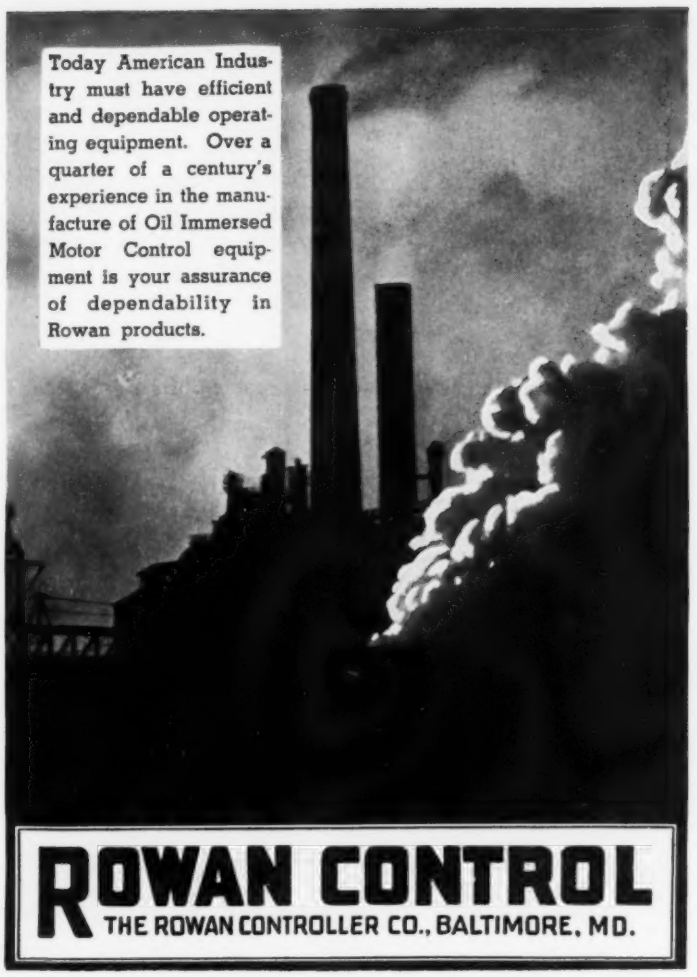
When additional interlocks and relays are provided on panels where safety to machinery and life is not involved, the control designer feels that the complications introduced are not warranted, and further, that the maintenance is increased and accessibility handicapped.

The designer's first thought, therefore, must be to the simplicity of the equipment, making it just as simple as possible, consistent with the safety of the machine and operator. The question of "degree of fool-proof" protection is one over which considerable discussion arises, and those in charge of operation and maintenance can contribute much to clarify the extent to which this protection is to be carried.

The trend towards mounting controllers in separate cabinets, motor rooms or enclosed alcoves has proven worthwhile. The saving in maintenance and the longer life of control so protected is now recognized.

The trend toward grouping of push buttons, meters, etc., into a wall cabinet or control desk for mounting at a central control point is gaining favor, and the designer has furnished a unit convenient to the operator and with the accessibility necessary for continuity of service.

We can predict that future devices will be designed as unit devices with greater creepage. Coil and interlock studs will be eliminated to prevent arc over. Relays and interlocks will have more positive self-cleaning contacts.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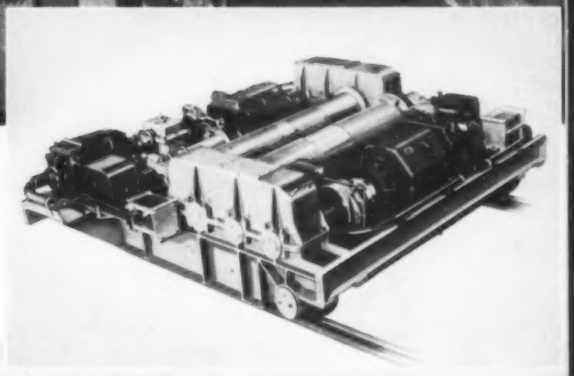
It may not always be possible for these devices to have an appearance entirely pleasing from an artistic standpoint, but appearance has two meanings. One meaning suggests the picturesque or artistic, without respect to operation, and the other, which is preferred, defines appearance as having the characteristics of ruggedness, simplicity and quality. It is the latter which we might call "operating appearance." This is what is needed; if the product in addition is artistic, so much the better.

The designer has the advantage of research, experimental facilities and infrequent trips to the field to give him new materials and new ideas for his designs but he must look to those who are continuously in contact with the equipment under actual operating conditions in the real proving ground — the mills — to offer constructive criticisms of the product.

We have talked briefly of a number of subjects illustrative of what maintenance can bring to design and what design can bring to maintenance. Many more improvements, new designs, new tools and new systems which are being developed for the war effort will become available for industry in general later. Systems are being designed with more power requiring better protection of the control against high current shorts. This problem is being studied by the designer and recently on high voltage, 2300 and 4600 volts, a new fuse has been incorporated in these controllers which adequately supplies this protection. There are many more examples, all of which point directly to the benefits developed from this partnership and the need for more effective use of this team.



MORGAN 60-TON, 100' 0" SPAN HEAVY-DUTY MILL TYPE CRANE

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● Illustrated is one of two Morgan heavy-duty mill type cranes in a strip mill. Morgan superiority of design and construction is built into every part to insure many years of profitable service. They are equipped with fabricated welded trolleys and bridge trucks, hydraulic bridge brakes and anti-friction bearings throughout. Trolleys are of the gear box type using plain motors with flexible couplings. An auxiliary girder is provided for helping to support the cage, bridge motor and control units. Morgan engineers rely upon a highly skilled shop organization, modern equipment and progressive ideas in building heavy-duty mill type cranes.

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Temperature Control of

By Howard Halstead

ASST. COMBUSTION ENGINEER

Bethlehem Steel Company

SPARROWS POINT, MARYLAND

Presented before A. I. S. E.
PHILADELPHIA DISTRICT SECTION

▲ SPELTER temperature is an important factor affecting the overall efficiency of the hot dip galvanizing process. Its importance is generally recognized and emphasized in the information which has been written about the process. Spelter temperature affects the cost of heating, the rate of dross formation, the life of the galvanizing kettle, and the structure of the galvanized coating. Therefore, to minimize the affects of variations in spelter temperature, automatic temperature control is applied to galvanizing kettles.

Speaking generally of any system of heat exchange, the ease with which the temperature of one side of the exchanger can be controlled depends upon characteristics inherent to the system itself. Those characteristics which are favorable to constant temperature control, together with their counterparts as found in the specific case of the hot dip galvanizing kettle, are listed as follows:

1. *Large demand side thermal capacity* — The demand side thermal capacity of the galvanizing kettle is the amount of heat required to raise the spelter temperature one degree. It is directly proportional to the volume of spelter contained in the kettle.

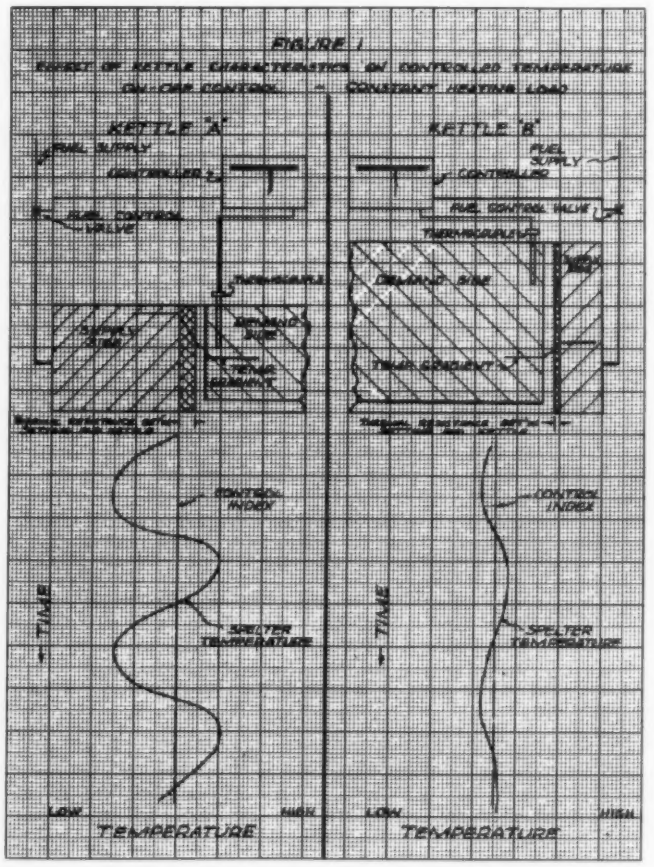
2. *Small supply side thermal capacity* — The supply side thermal capacity of the externally heated galvanizing kettle is the heat required to raise the temperature of the refractory setting surrounding the kettle one degree. Decreasing the mass and specific heat of the refractory surrounding the kettle, decreases the supply side thermal capacity.

3. *Minimum temperature difference between supply and demand sides* — This temperature difference, in the externally heated galvanizing kettle, is the temperature difference between the refractory setting surrounding the kettle and the spelter contained in the kettle. For kettles requiring the same heat input, increasing the kettle heating surface and decreasing the thermal resistance between setting and kettle, decreases the required temperature difference.

4. *Minimum transfer lag* — Transfer lag in the galvanizing kettle is the time interval required for a change in the rate of heat input to the refractory setting surrounding the kettle to produce a corresponding change in spelter temperature. Transfer lag can be reduced by decreasing the supply side thermal capacity of the kettle and by decreasing the thermal resistance between setting and kettle.

To further illustrate the effects of these characteristics, Figure 1 represents two galvanizing kettles, "A" and "B." These kettles have no counterparts in actual practice; neither are the temperature curves actual spelter temperature records taken from a practical kettle installation. They do serve, however, to illustrate how different kettle characteristics affect the application of temperature control to the kettle.

In each case it is assumed that the heating load due to material being galvanized is constant and identical for each kettle. A thermocouple located in each spelter bath measures spelter temperature. A two position, on-off controller attempts to regulate the bath tempera-



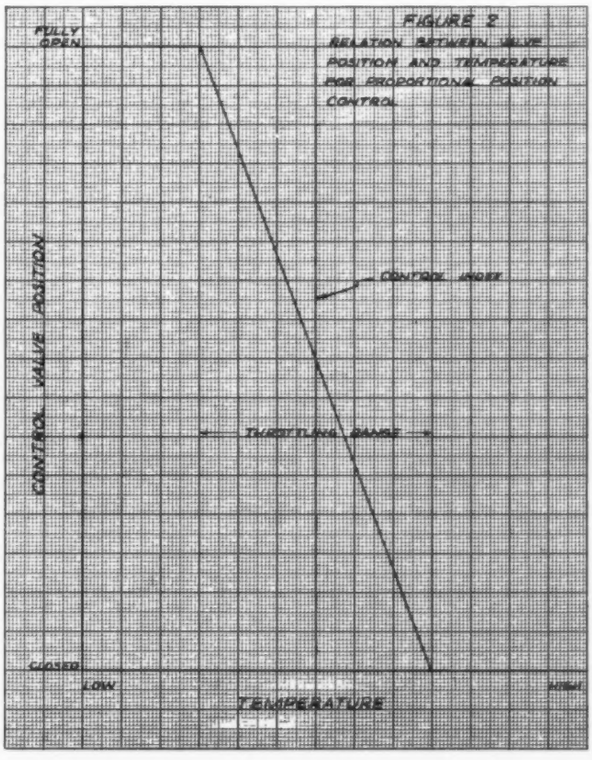
GALVANIZING KETTLES

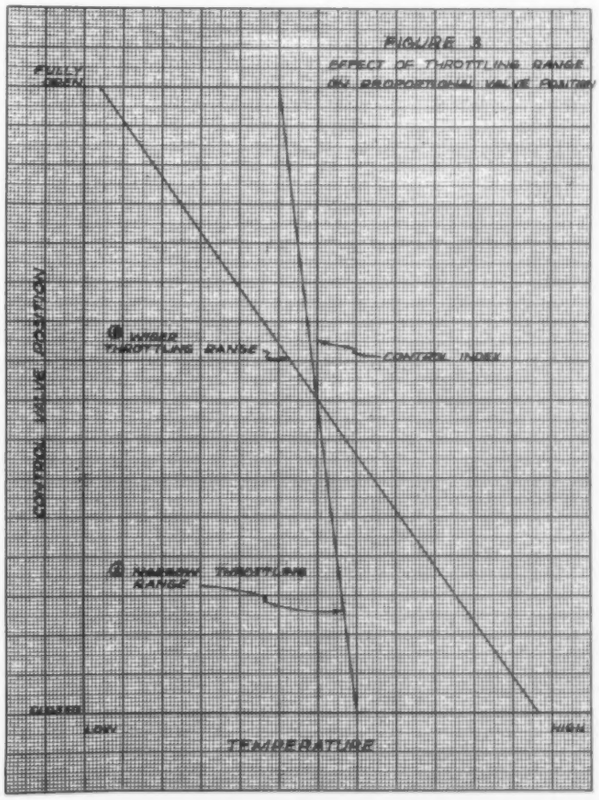
ture by positioning a valve located in the fuel supply line. As the temperature records under each pot indicate, kettle "B" is more favorable to temperature control than kettle "A." It is more favorable for these reasons:

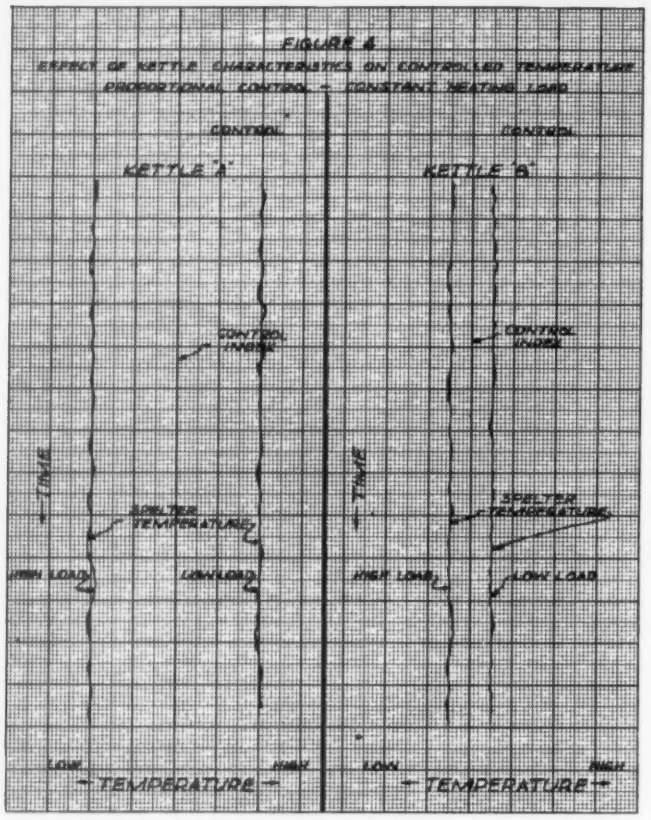
A. Its demand side thermal capacity is larger because the spelter volume of the kettle is larger.
B. Its supply side thermal capacity is smaller, because both the mass and specific heat of the refractory surrounding the kettle are smaller.
C. The average temperature difference, as indicated by the temperature gradient between setting and kettle, is less. This difference is less because kettle "B," being deeper, has more square feet of exposed kettle heating surface. The resistance to heat transfer from the setting to the outside kettle surface is also less.
D. The transfer lag in kettle "B" is less because the resistance to heat transfer between setting and kettle is less, and because its supply side thermal capacity is less.

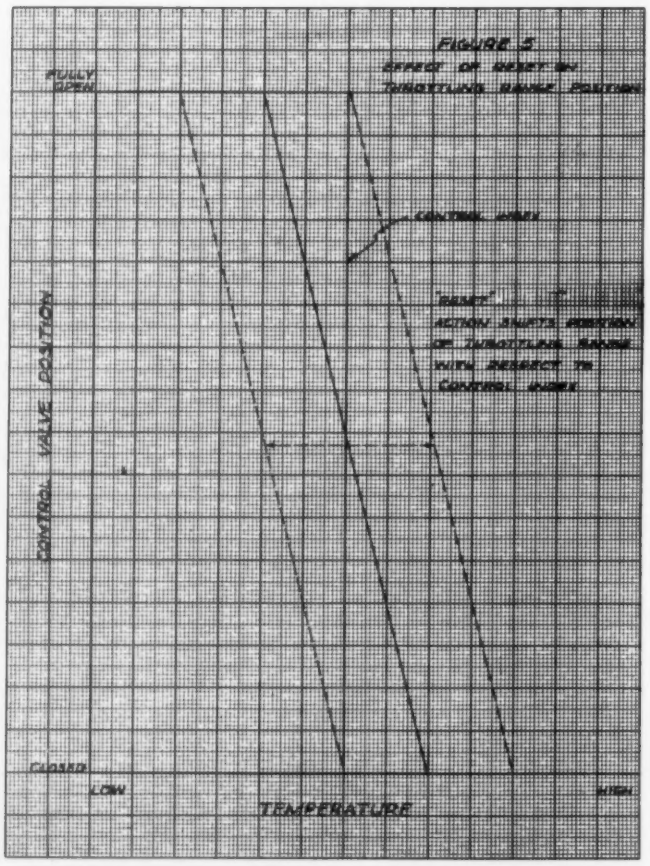
. . . . hot dip galvanizing installations should have ample kettle volume, adequate heating surface, minimum thermal storage, wide fuel turndown range, and proper temperature control . . . .

Consider that portion of the spelter temperature curves for kettles "A" and "B," Figure 1, in which the spelter temperature is below the control index and is rising. In each case the fuel valve is in the open position. As the spelter temperature rises above the control index, the controller closes the valve supplying fuel to the refractory setting. Because of the heat stored in the supply sides of both kettles, the spelter temperatures continue to rise. However, the heat stored in the supply









side of kettle "B" is less than that stored in the supply side of kettle "A," because its supply side thermal capacity is less and its supply side temperature is lower. In addition, more heat per degree is required to raise the spelter temperature of "B," because its demand side thermal capacity is greater. For these reasons the temperature rise above the control index is less in kettle "B" than in kettle "A."

Similarly, the spelter temperature of "B" does not drop as far below the control index as does the spelter temperature of "A."

Fortunately, control instruments have been developed which can be adjusted to minimize these differences in kettle characteristics. In addition to the fixed position controller, just illustrated, there are two other general classes of temperature controllers. These are the proportional position control and the proportional position control with automatic reset.

Briefly, in the proportional position control, the position taken by the fuel control valve is proportional to the temperature deviation from the control index. Figure 2 illustrates this graphically. The temperature span between the fully opened and fully closed valve position is termed the "throttling range" of the instrument. In those instruments having an adjustable throttling range, the temperature span between extreme valve positions can be adjusted. Figure 3 illustrates this graphically. In Figure 3, curve 1, the temperature span between extreme valve positions is small, or the throttling range is narrow; and, in curve 2, the temperature span between extreme valve positions is large, or the throttling range is wide. Generally speaking, the more favorable the process characteristics, the more narrow the throttling range may be, to produce a uniform controlled temperature curve.

One characteristic of the proportional position controller is that the controlled temperature does not necessarily coincide with the control index. This deviation of controlled temperature from the control index increases with increasingly wider throttling range and varies with varying load conditions.

Consider the application of proportional control to the two galvanizing kettles in Figure 1, "A," with unfavorable control characteristics and "B" with favorable control characteristics. To produce a uniform spelter temperature curve, the throttling range of the controller must be wider for kettle "A" than for kettle "B." The controlled temperature curve for both kettles would be uniform, but each would deviate from the control index as illustrated in Figure 4. The deviation would be larger for kettle "A" than for kettle "B," because the throttling range of the proportional position controller is wider.

The temperature curves marked "high load," shown in Figure 4, result from the same constant and relatively high heating load imposed on each kettle. If the heating loads were reduced on both kettles, the spelter temperature curve would approach the control index. At one condition of constant heating load, the spelter temperature curve would coincide with the control index. If the heating loads were further reduced, the spelter temperature curves would rise above the control index. The temperature curves marked "low load," shown in Figure 4, result from the same constant, but

relatively low heating load imposed on each kettle. The temperature span between the high load and low load curves is greater in kettle "A" than in kettle "B," because the throttling range adjustment, necessary to produce a uniform spelter temperature curve in each case is wider for kettle "A" than for kettle "B."

In proportional control with the automatic reset feature, provision is made for automatically shifting the throttling range with respect to the control index. In Figure 5, as a result of the reset action, the curve showing the relation between temperature and control valve position can be shifted to either of the two extreme positions shown by the dotted curves. The action of the controller would be to return the controlled temperature curve to the control index.

Figure 6 illustrates the resulting temperature curves for the two kettles when proportional position control with automatic reset is applied to each.

As was stated originally, the resulting controlled temperature curves shown in Figure 1, 4, and 6, were for conditions of constant heating load.

Change in heating load conditions causes a corresponding deviation of the controlled temperature from the control index. The automatic controller attempts to counteract the effects of heating load changes on controlled temperature by repositioning the fuel control valve.

The more favorable the process characteristics, the more nearly the controlled temperature curves coincide with the control index.

The resulting controlled temperature curves for kettles "A" and "B" operating under the same varying load conditions would be as illustrated in Figure 7. Curve 1 represents the varying heating load or demand imposed upon each kettle; curves "A" and "B" represent the resulting spelter temperature curves when proportional position control with automatic reset is applied to each kettle. The spelter temperature curve for kettle "B" more nearly coincides with the control index.

All automatic temperature controllers presuppose that the heat input to the refractory setting is at least roughly proportional to the control valve position. To illustrate this, Figure 8 plots heat input to the setting, versus valve position for several control valves. Curves "A" and "E" are entirely unsuitable for use with any control other than the on-off type. Curves "B," "C," and "D" may be considered as all relatively satisfactory.

Unfortunately an exact quantitative analysis of the net effect on temperature control of the various kettle and heating equipment characteristics is impractical. However, with the general characteristics favorable to temperature control in mind, certain desirable features in design are indicated.

With respect to control of spelter temperature, a galvanizing kettle installation may be broken down into four component parts; namely, (1), the size of the kettle; (2), the construction of the refractory setting surrounding the kettle; (3), the choice of heating equipment; and, (4), the selection of temperature control equipment. Following are brief discussions of each of these component parts:

1. *Kettle size* — The size of the kettle limits not only the spelter volume, or demand side thermal capacity, but it also limits the area of exposed kettle heating surface.

Most kettles are designed to provide sufficient spelter volume not only to aid in maintaining constant spelter temperature, but to provide a reservoir in the bottom of the kettle for the accumulation of dross formed during galvanizing, to accommodate the overall dimensions of the material being galvanized, and, in continuous galvanizing installations, to provide sufficient immersion time for the material being galvanized.

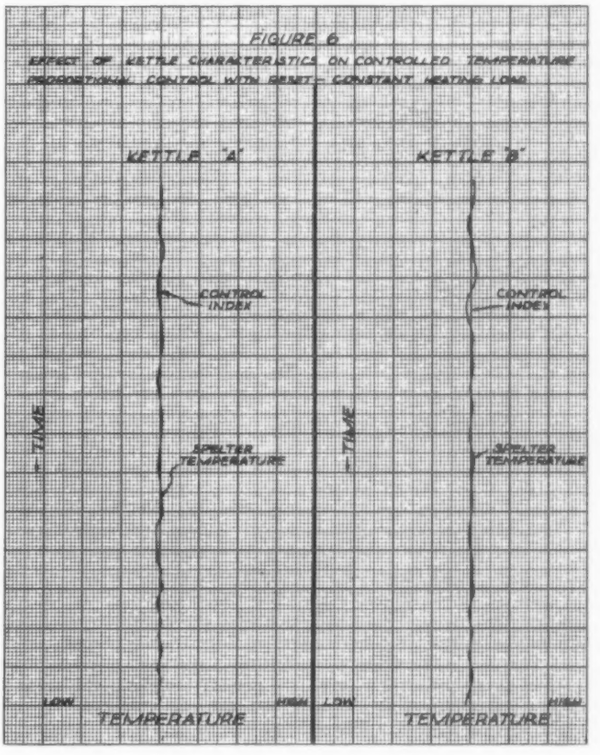
As a guide, the following figures, based on several externally fuel-fired, continuous galvanizing installations may be used in determining kettle size:

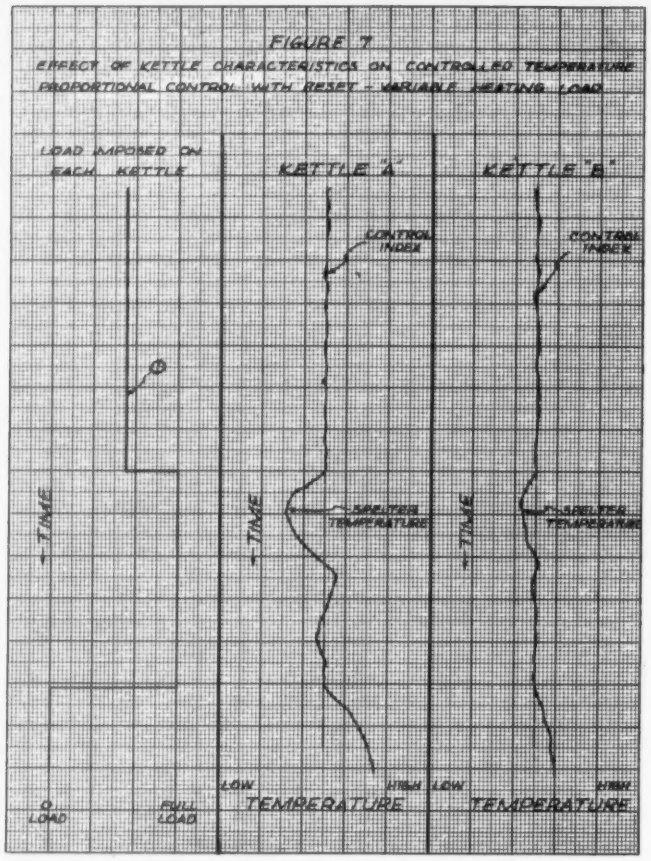
A. Allow 50 cubic feet of kettle volume for each net ton of steel galvanized per hour.

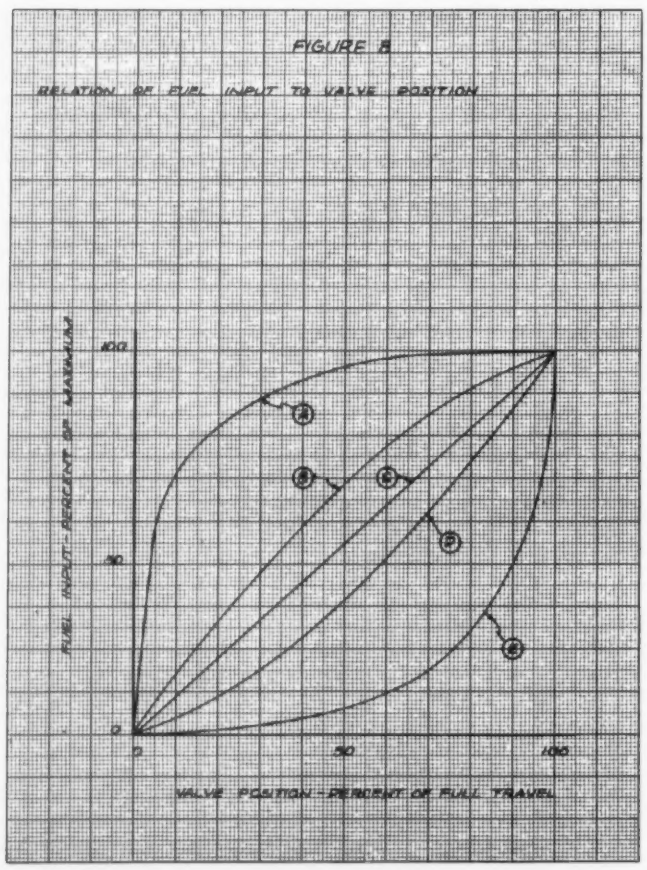
B. Allow one square foot of exposed kettle heating surface for each 12,000 Btu per hour heat input through the kettle walls. It is recommended that only the upper two-thirds of the kettle walls be considered as available heating surface.

In addition, good galvanizing practice indicates that the majority of heat be applied to the upper third of the kettle and in such a manner as to prevent local overheating of the kettle walls. The extreme top portion of the kettle, between the top of the kettle and minimum spelter level, should be protected by refractory placed adjacent to the kettle wall.

In one wire galvanizing installation the heating surface was increased by firing on the top surface of the spelter bath. The spelter was protected from oxidation by a light cover of granular carborundum.







2. *Refractory setting* — To minimize the effect of supply side thermal capacity, the mass of refractory used in the setting should be kept at a minimum. Whenever practicable, the use of light weight refractory of low volumetric specific heat is recommended.

In those electrically heated kettles, surrounded by a simple wall of low specific heat refractory, supply side capacity is very low. Similarly, radiant tube firing, when surrounded by a simple wall of light weight refractory, provides relatively low supply side thermal capacity.

In several of the conventional externally fuel-fired setting designs, refractory mass and volumetric specific heat are high. The mass is high because of the inclusion in the setting of refractory partitions and baffles to prevent flame inpingement on the kettle and to assure even distribution of heat along the kettle. Refractory setting temperatures are high because the maximum rates of heat transfer per square foot of exposed kettle surface are high. However, to withstand the high setting temperatures, the refractories used must have high volumetric specific heat. The resulting combination of high setting temperature and high setting thermal capacity has an unfavorable result on the control characteristics of the kettle.

In one experimental installation, supply side thermal capacity was reduced to an absolute minimum by firing premixed air and gas in steel heating elements immersed in the spelter itself. Unfortunately, the short life of the steel elements when immersed in molten zinc at galvanizing temperatures caused this method of firing to be abandoned.

3. *Heating equipment* — In selecting the heating media — whether electricity, gas, or oil — cost, availability, and, ease of control should be considered.

In all installations it is desirable, and in some absolutely necessary, that the heat input to the kettle be shut off completely during parts of the controlled temperature cycle. In this respect, electricity is most readily adapted to automatic control. Where gas or oil are automatically controlled, provision must be made for insuring their ignition, after control periods of zero fuel input to the setting. Small pilot burners or electrical ignition may be used to accomplish this.

Multiple burner firing or a large number of small burners is advantageous in securing proper distribution of heat along the kettle walls. Where low individual burner capacity is desired, gas is more suitable as a fuel than oil. Where multiple burner firing is used, the burners, either oil or gas, may be arranged in groups, the fuel to one or more groups being completely shut off during parts of the controlled temperature cycle.

Forced convection heating, or the forced recirculation of flue products around the kettle walls, has been used for heating galvanizing kettles. The resulting increased flue gas velocity lowers the resistance to the transfer of heat between setting and walls, with a corresponding decrease in required setting temperature. This is a feature favorable to the application of automatic control. However, the additional flues and circulating equipment add to the supply side thermal capacity of the setting.

Fouling of the kettle heating surface by zinc oxide or soot from the fuel increases the resistance to heat

transfer between setting and kettle. The resulting increase in setting temperature necessary to maintain the required heat input to the kettle has an unfavorable effect on control characteristics.

In one instance, where forced recirculation of flue products was used, zinc oxide picked up from spelter which had leaked into the setting flues and deposited on the kettle walls, increased thermal resistance to such an extent that the heating capacity of the kettle was materially reduced.

4. *Control equipment* — In selecting temperature control equipment, the advice of the various instrument manufacturers is recommended. Not only have general control instruments been developed which minimize the effect of unfavorable process characteristics on the control of temperature, but control arrangements, specifically applicable to the special case of the galvanizing kettle are available.

In one control arrangement a secondary thermocouple, located in the setting surrounding the kettle, limits the maximum setting temperature. By so doing, the kettle is protected from over-heating and the unfavorable effect of high supply side heat storage on the controlled temperature is reduced.

In another arrangement, provision is made for blowing cold air into the setting surrounding the kettle to reduce the increase in spelter temperature following heating load reductions.

Fuel control valves having the favorable flow characteristics shown in curve "B," "C" and "D" of Figure 8, are readily obtainable. Knowing the physical characteristics of the fuel and the maximum desired flow, the proper valve can be selected from manufacturers' data.

The control installation must be protected from the fume and dirt common to the majority of hot dip galvanizing installations. It is recommended that the control equipment be located in an enclosed gauge house adjacent to the galvanizing kettle.

In summarizing, the features to be incorporated in the design of a hot dip galvanizing installation when constant and uniform control of spelter temperature is desired, are these.

1. Provide ample kettle volume.
2. Provide adequate heating surface area.
3. Design the refractory setting for minimum thermal capacity.
4. Provide for low turndown capacity of the heating media.
5. Consult the various control manufacturers regarding the proper selection and installation of the temperature control equipment.

DISCUSSION

PRESENTED BY

MARTIN J. CONWAY, Special Engineer, Lukens Steel Company, Coatesville, Pennsylvania

HOWARD HALSTEAD, Assistant Combustion Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

W. N. HORKO, Engineer, Henry Disston & Sons, Inc., Philadelphia, Pennsylvania

D. LEWIS, Engineer, John Roebling Sons Company, Trenton, New Jersey

O. B. PYLE, Engineer, Brown Instrument Company, Philadelphia, Pennsylvania

C. S. STOUFFER, Works Engineer, Stanley G. Flagg & Company, Stowe, Pennsylvania

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

MARTIN J. CONWAY: I have one compound question to ask Mr. Halstead, who is to be congratulated for his presentation of his study of galvanizing kettles.

What is the comparative square feet of fired area on the kettles A and B and the comparative poundage of smelter in the two kettles, per square foot of fired area, also the amount of dross produced per ton of material coated in kettles A and B?

HOWARD HALSTEAD: Unfortunately an exact quantitative analysis of the factors affecting temperature control is impractical. The kettles shown were not drawn to an exact scale. They serve merely to illustrate this principle; that, under similar pot operating conditions, the kettle having the larger volume and greater effective heating surface is more easily adapted to automatic control of temperature.

The dross formed by the solution of the kettle wall should be less in the larger kettle because the inside surface temperature of the kettle wall is less

W. N. HORKO: Some time ago, we investigated a device for maintaining a constant oil-air ratio for oil burners. I had the pleasure of seeing in operation a galvanizing kettle which had one of these devices on it. I noticed they had a very oxidizing atmosphere from the burner and I asked why that was, and it was claimed that by using the oxidizing atmosphere they had less dross, better temperature uniformity and longer kettle life due to the fact they did not have a luminous flame. You could not see any flame at all, merely the products of combustion throughout the whole thing, and by operating that way the operator claimed they got longer life and a more uniform temperature control than when operating with a neutral or reducing atmosphere. I would like to ask Mr. Halstead if his experience has been similar.

HOWARD HALSTEAD: I believe that a long, luminous flame heats faster and more evenly than a short bright flame or a non-luminous flame. Such a flame results from deficiency rather than an excess of primary air.

D. LEWIS: Mr. Halstead mentioned heating a spelter bath from the urface but did not say much about it. If you did that of course you would not need to have a pot. You could put the spelter in refractory and that would reduce the dross. I would like more information on that subject.

HOWARD HALSTEAD: At Sparrows Point we have two, top fired kettles for galvanizing wire. The spelter is contained in a steel kettle. The top firing is augmented

by auxiliary side firing. The purpose of top firing is to increase the effective heating surface.

O. B. PYLE: I would like to know the kind of protecting tubes used on the thermocouples and the average length of life of the tubes.

HOWARD HALSTEAD: We use extra heavy iron pipe protecting tubes. Our couple life approximates three months.

C. S. STOUFFER: Our kettles are 20 ft long and we galvanize around 20 tons per day of metal castings. We have effected a marked reduction in the formation of dross by using an extremely deep kettle, so that the dross can settle to the bottom; by cleaning that out at frequent intervals, we found a decided improvement in our kettle performance.

I don't know whether that has any bearing on Mr Halstead's subject; it is simply that it has been an experience in galvanizing malleable castings.

HOWARD HALSTEAD: Deep kettles hould be advantageous in securing settling dross.

A. J. FISHER: I would like to comment on Mr. Halstead's paper to re-emphasize the fact that he is trying to bring out that most of us as engineers have not given the galvanizing setting problem enough serious consideration. We go along and put these kettle components together not knowing what makes good temperature control and what does not. Then we got to the instrument manufacturer and ask him to control the kettle and if he does not control it properly we give him "the works." Now it isn't all his fault if it doesn't do a good control job. We as engineers have to do our part first; then when we turn the problem over to the instrument man, he can do his job. However, we must do our part first.

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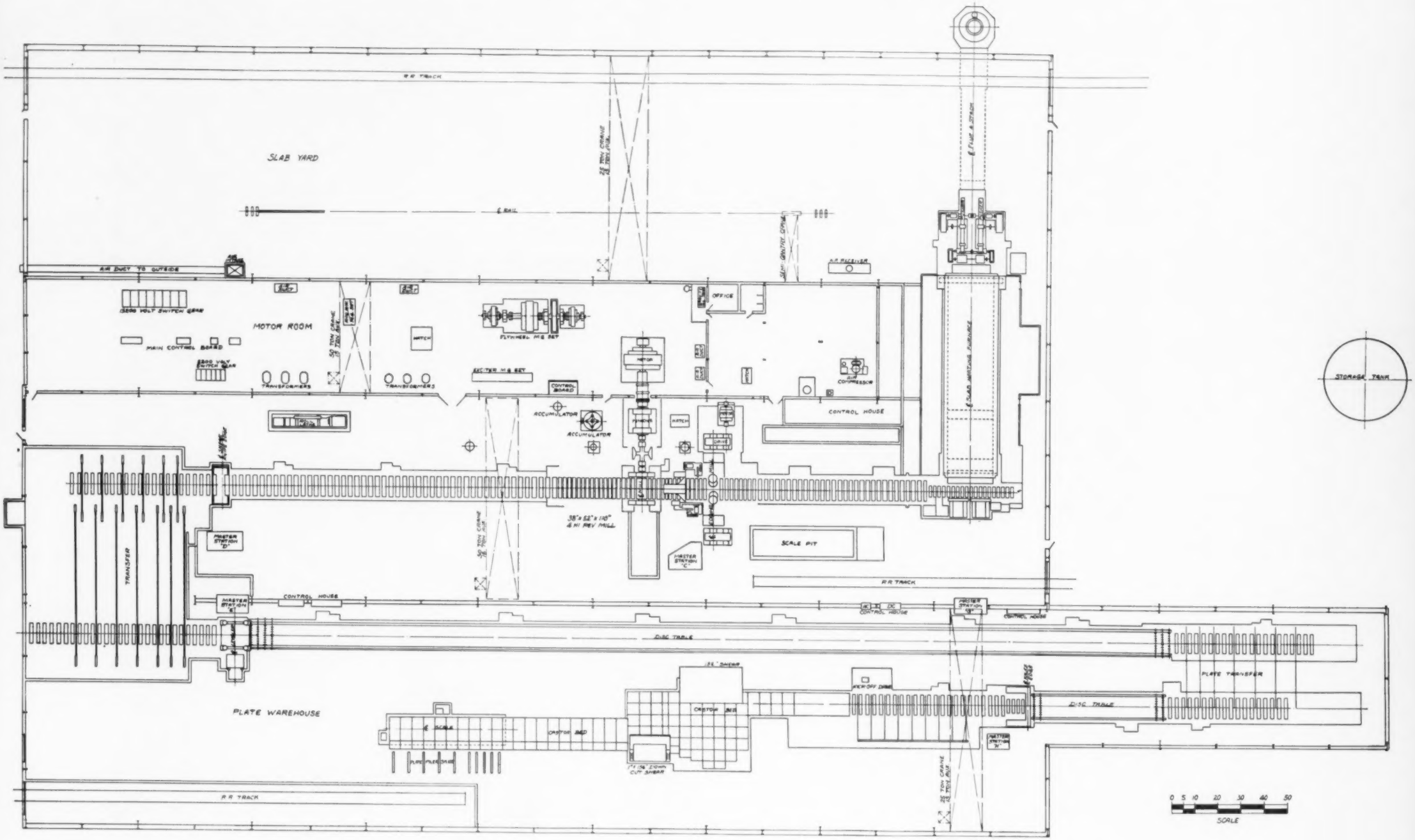
Figure 1 — General arrangement of 110 in. reversing plate mill and its auxiliaries.



Electrical Drives for a 110" Reversing PLATE MILL

By C. J. Porter — Electrical Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario

C. A. Price — Chief Engineer, Canadian Westinghouse Co., Ltd., Hamilton, Ontario

A. F. Kenyon — Steel Mill Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

. . . . laid out to meet a wide range of operating conditions, this 110 in. plate mill embodies many modern features of design and construction . . . .

Presented before A. I. S. E. SPRING CONFERENCE, HAMILTON, ONTARIO

▲ THE 110 in. wide reversing plate mill at the Hamilton plant of the Steel Company of Canada, Ltd. was laid out to meet a rather wide range of operating conditions, and to enable economical operation with the expected rather moderate tonnage of widely varying products. Under the present war conditions, the mill is of course being operated at maximum capacity rolling ship and structural plate. However the complete plan envisages the future installation of a following continuous strip finishing train, and the use of the present reversing mill as the roughing breakdown unit of a semi-continuous hot strip mill, as well as a complete plate rolling mill in itself. The electrical drive equipment for the reversing plate mill was selected to have characteristics suitable for either the heavy plate rolling or lighter strip breakdown work.

Preliminary plans for the mill were developed in 1938, and early in 1940 the company management decided to proceed with the installation of the reversing plate mill, and plate finishing equipment. Orders for the principal equipment were released in April, and the installation was completed and the first plate rolled less than one year later, on March 31, 1941. In the first year's operation, the performance of the mill has fully met all expectations, and present production is in excess of the estimated maximum capacity.

Mill Arrangement

The general arrangement of the reversing plate mill, with slab yard, reheating furnace, transfers, and plate handling and finishing equipment, is shown in Figure 1. The mill is of the modified universal type, consisting of a four-high main horizontal roll stand, and an auxiliary vertical roll scale breaking and edging stand. The vertical edging stand is located between the reheating furnace and the main roll stand, so that a heavy scale breaking edge pass may be taken before starting the flat reducing passes in the main mill. The vertical edging mill is installed 31 ft 4 in. from the main mill, to afford space for the installation of the high pressure water descaling spray, slab turnaround, and slab pusher. Under present conditions, practically the entire production is wide sheared plate, and the edger is used only for a heavy initial pass (usually about 2 in.) to break the scale, after which the rolling is completed in the main mill. When rolling narrow universal plate, or bar for hot strip, the slab may be run back through the edger for additional edging passes.

Main horizontal mill — The main mill stand is of the four-high roll arrangement, to provide the necessary stiffness and bearing capacity to enable rolling wide

Figure 2 — The main mill stand is spaced 31 ft 4 in. from the separate edging stand.

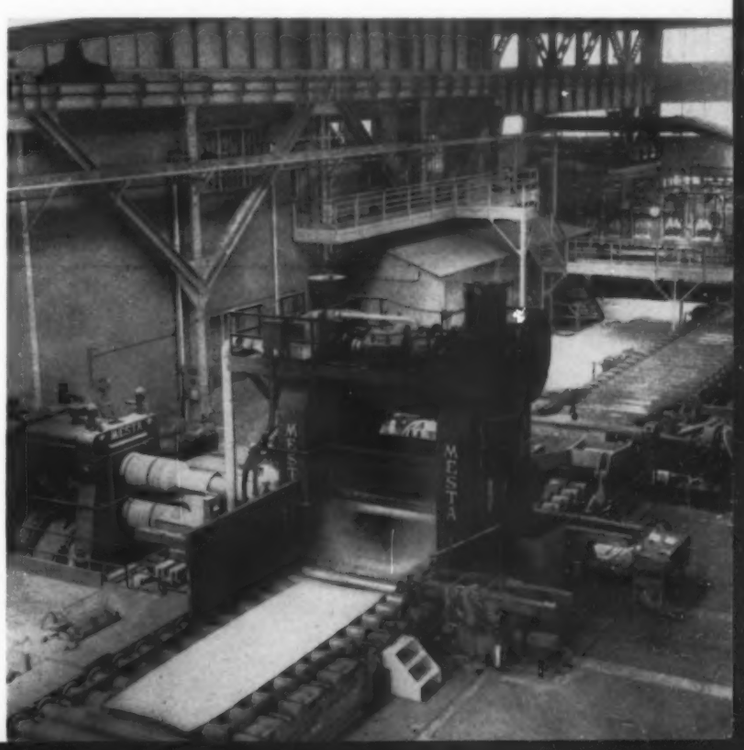


plate of uniform thickness. The working rolls are nominally 38 in. diameter by 110 in. long body, to permit rolling plate up to about 100 in. maximum sheared width. The backing-up rolls are 52 in. nominal diameter, and are supported in oil pressure sleeve bearings.

The mill working rolls are directly connected through spindles and pinion stand, to the 5000 hp, 35/80 rpm main reversing motor, thus providing a mill speed range of 350/800 fpm. Rolling relatively short wide sheared plate, it is found that most passes are made at about 25 to 35 rpm, and the control has been arranged to limit the maximum speed to about 50 rpm. However it is expected that higher speeds will be advantageous when rolling long universal plate or bar for strip.

Vertical edging mill — The vertical edging rolls are 40 in. nominal diameter, and are driven through bevel and spur reduction gearing by a 500 hp, 125/406 rpm reversing motor, which is located in a pit below the mill floor, outside the motor-room. The gear ratio between the motor and edging rolls is 6.67:1, thus providing a mill speed range of about 197/640 fpm. For the present operation using the edger only for a heavy scale breaking pass, the motor is operated only up to its base speed of 125 rpm, however the higher weakened field speeds will be required when rolling long plates, with the plate in both the main and edging mills at the same time.

Figure 2 is a view of the plate mill, taken from the delivery side, showing the reheating furnace in the background, and the main and edging mills in the middle foreground. The view also indicates the location of the glass enclosed mill control pulpit opposite the table between the main and edging mills, where the operators may have a clear view of the mill operations.

Electrical Drive Equipment

The main electrical equipment for the 110 in. plate mill is housed in a brick and steel motor room, 300 ft long by 50 ft wide, located between the slab yard and the mill building. The motor room is served by an overhead electric crane having a 50 ton main hoist, and 15 ton auxiliary hoist, thus affording capacity to lift any part of the electrical equipment, and facilitating installation, maintenance, and repair. Figure 3 is a general view of the motor room, showing the 5000 hp reversing motor, flywheel set, and exciter set, in the foreground, and the auxiliary transformers, auxiliary motor generator set, and switchgear at the farther end of the motor room.

Power supply — The single line diagram of the power distribution system is shown in Figure 4. Power for the operation of the plate mill is purchased from the Hamilton Hydro-Electric System, and is supplied through two 6,000 kva, 13,200 volt, 3 phase, 25 cycle underground lead-covered cable lines about 3,800 feet long, from the Hydro 13,200 volt substation. Provision is made for the connection of reactors in these lines and in whatever additional lines are necessary for the ultimate load when the strip mill is added. It is anticipated that the strip mill load will include a large capacity in synchronous motors. The metal-clad oil circuit breakers

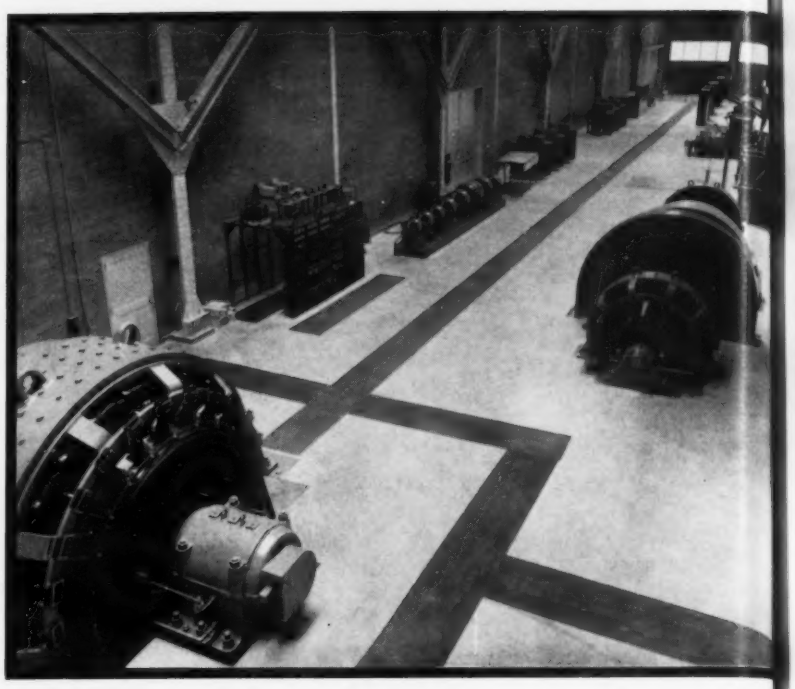
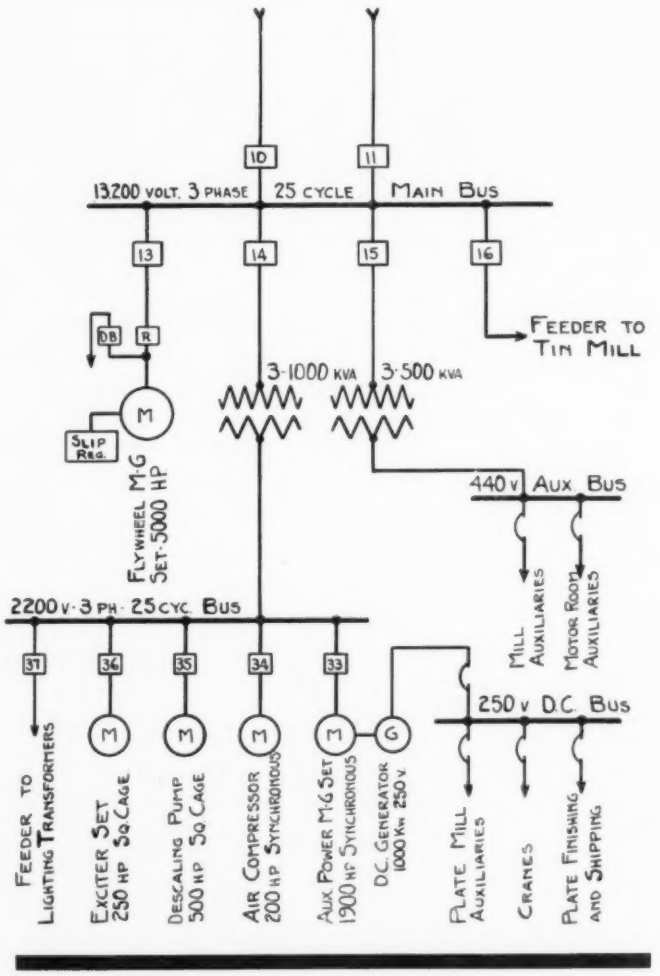


Figure 3 — General view of the motor room, showing drive and control equipment.

Figure 4 — Single line diagram of power circuits in the 110 in. plate mill substation.



controlling the 13,200 volt circuits in the plate mill are of 500,000 kva rated interrupting capacity.

The 5,000 hp wound rotor induction motor driving the reversing mill flywheel motor generator set is wound for 13,200 volts, and takes power directly from the 13,200 volt bus.

A transformer bank consisting of three 1,000 kva, 13,200/2,200 volt, single phase, delta-delta connected transformers furnishes 2,200 volt, 3 phase, 25 cycle, power to the larger a-c motors, including:

1900 hp synchronous motor driving 1000 kw auxiliary power motor generator set.
500 hp descaling pump motor.
200 hp air compressor motor.
235 hp motor driving the reversing mill exciter motor generator set.
325 kva lighting transformers.

The 2,200 volt bus is grounded through a zig-zag grounding transformer, and each of the 2,200 volt load circuits is protected by leakage current ground relays. The 2,200 volt circuits are controlled by metalclad oil circuit breakers of 100,000 kva rated interrupting capacity.

A bank of three 500 kva transformers furnishes 440 volt, 3 phase, 25 cycle power for the smaller a-c motors, driving ventilating fans, oil and water pumps, plate shears, etc. in the motor room, and in the plate mill.

As a general rule, a-c motors up to 100 hp are 440 volt, while larger motors are 2,200 volt.

In selecting the transformers for the 2,200 volt and 440 volt power supplies, consideration was given to the ultimate capacities which will be required for the completed strip mill installation, as well as for the present plate mill, and the decision was that the transformers to serve the ultimate loads should be arranged in two small banks, rather than in one larger bank, in order to limit possible short circuit currents to a lower value, and thus reduce the interrupting duty on the low voltage circuit breakers.

Direct current power at 250 volts, for the cranes and mill auxiliaries, is furnished by a 1,000 kw synchronous motor generator set, and provision is made for the future installation of two additional 1,000 kw sets.

With the exception of short feeders serving control rooms and motors close to the motor room, the main 440 volt a-c and 250 volt d-c feeders and the 2,200 volt primary feeder to the lighting transformers are carried in the building roof trusses. Suitable dead-end anchorages were arranged for in the building design, and in a portion of one bay between columns, the roof valleys were raised to permit the passage of cross feeders.

Reversing mill main drive — The electrical drive for the working rolls of the main and edging mills of the reversing plate mill consists of a 5,000 hp and 500 hp direct current reversing motors, operating from the variable voltage power supplied by a 5,000 kw flywheel motor generator set, together with the necessary exciter set, main d-c circuit breakers, and variable voltage magnetic field control equipment.

Figure 5 shows the arrangement of the main drive equipment at one end of the motor room, with the 5,000 hp main reversing motor at the extreme end of the room, the slip regulator and 5,000 kw flywheel motor generator set along the left wall, and the exciter set

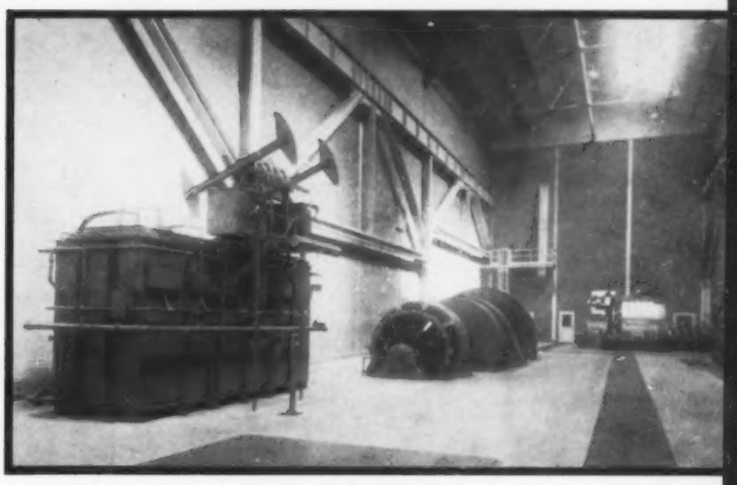
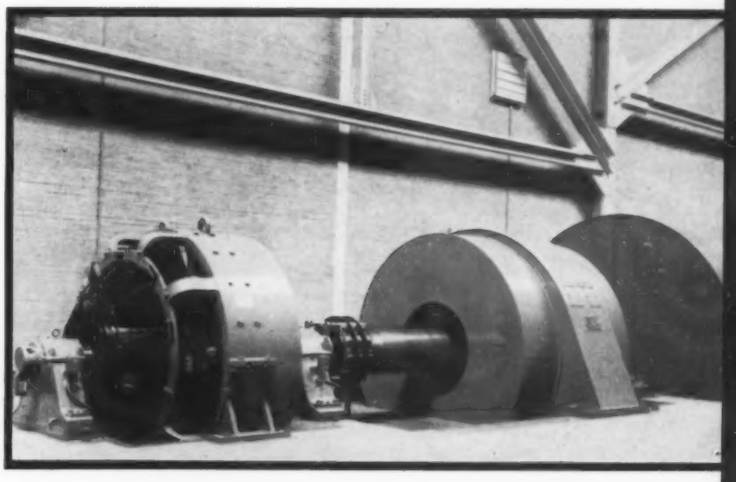


Figure 5 — Another view of the plate mill motor room, from opposite end of building.

Figure 6 — Close-up of main drive, a 5000 hp, 35-80 rpm, 700 volt single armature reversing unit.

▲

Figure 7 — This 5000 kw flywheel motor-generator set supplies power to the 5000 hp and 500 hp reversing motors.



and variable voltage magnetic field control and meter panels along the right wall.

The main reversing motor driving the upper and lower working rolls of the main horizontal mill is of single armature construction, and is rated 5,000 hp, 700 volts, 5,800 amperes, 35/80 rpm. The rated full load torque capacity at 35 rpm base speed is 750,000 pound-feet, and in emergency the motor can develop a maximum peak torque in excess of 2,000,000 pound-feet. This motor is of the same torque capacity as the 7,000 hp, 50/100 rpm motor driving the 44 in. blooming mill, and is built with similar mechanical characteristics but with the different armature winding and commutator required by the slower speed rating. A closeup view of this motor is shown in Figure 6.

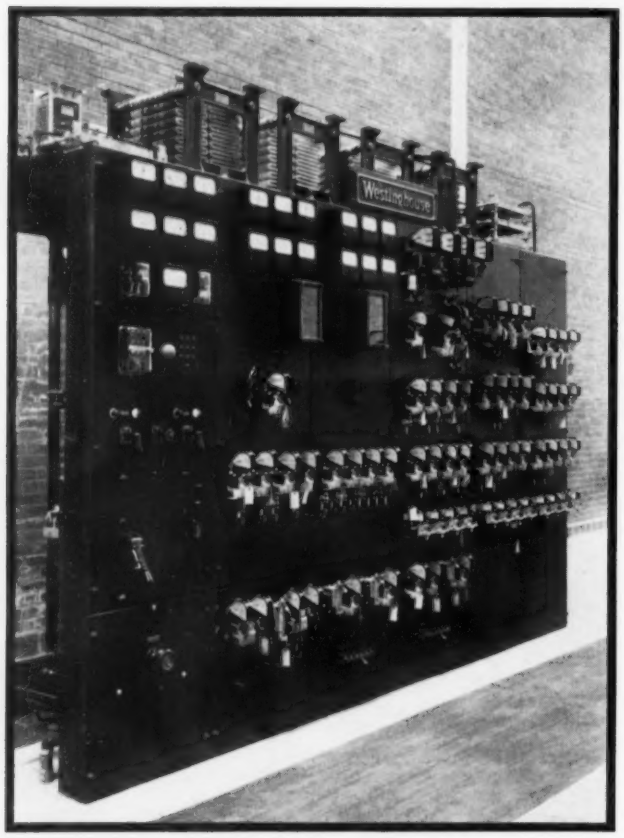


Figure 8 — Meter, relay and magnetic field control panels for reversing drive equipment.

▲

Figure 9 — This eight-unit exciter set provides separate excitation for each field circuit.

The edging mill motor is rated 500 hp, 700 volts, 125/406 rpm, with 21,000 pound-feet rated full load torque capacity at 125 rpm base speed, and 57,750 pound-feet maximum peak torque capacity. This motor is of special design with small diameter armature in order to reduce the WR^2 to a minimum and enable the edger to accelerate at the same equivalent rate as the main mill. The 500 hp motor is located in a pit below the mill floor outside the motor room, and is connected to the vertical edging rolls through bevel and reduction gearing of 6.67:1 total ratio.

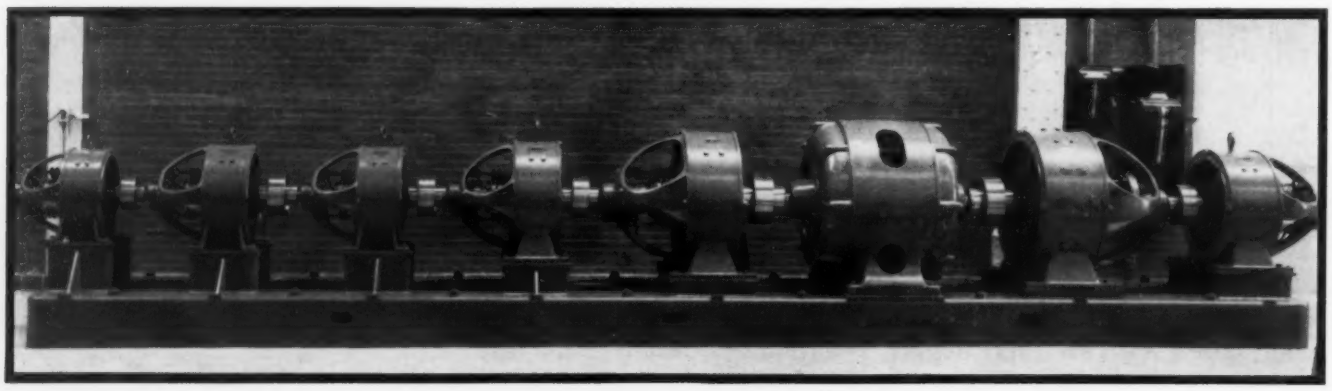
Power for the two reversing mill motors is supplied by a flywheel motor generator set (Figure 7) consisting of two 2,500 kw, 700 volt, 490 rpm d-c generators, a 5,000 hp, 13,200 volt, 3 phase, 25 cycle, 490 rpm wound rotor induction motor, and 90,000 pound steel plate flywheel. When running at 500 rpm the total stored energy in all of the rotating parts of the set is approximately 175,000 hp-sec. The 5,000 hp rating of the induction motor is larger than normally specified for a 5,500 hp reversing drive, but this excess capacity was considered desirable in view of the expected high average loads when rolling long plates, or roughing bar for hot strip.

The control of the main and edger motors is by the conventional variable voltage method, in which the total speed range is obtained by a combination of generator voltage and motor shunt field control. A separate exciter is provided for each field circuit, and control of the main machine excitation is effected by controlling the small field currents of the exciters, rather than the much larger field currents of the main generators and reversing motors. The magnetic field control and relay panels, and motor, generator, and exciter meter panels, are shown in Figure 8, and the exciter set is shown in Figure 9.

Figure 10 is a schematic diagram of the main and excitation circuits of the reversing drive equipment. Three features of the control equipment may be especially commented upon.

a. It will be noted that a heavy duty air circuit breaker is provided in the positive lead from each of the 2,500 kw generators, and in the positive lead to the 500 hp edger motor. However a circuit breaker is not provided in the 5,000 hp motor circuit, as this large motor is of practically the same maximum capacity as the two generators, and the motor is thereby amply protected by the generator circuit breakers.

b. The armature WR^2 and the field and exciter circuits of the 5,000 hp and 500 hp motors are carefully



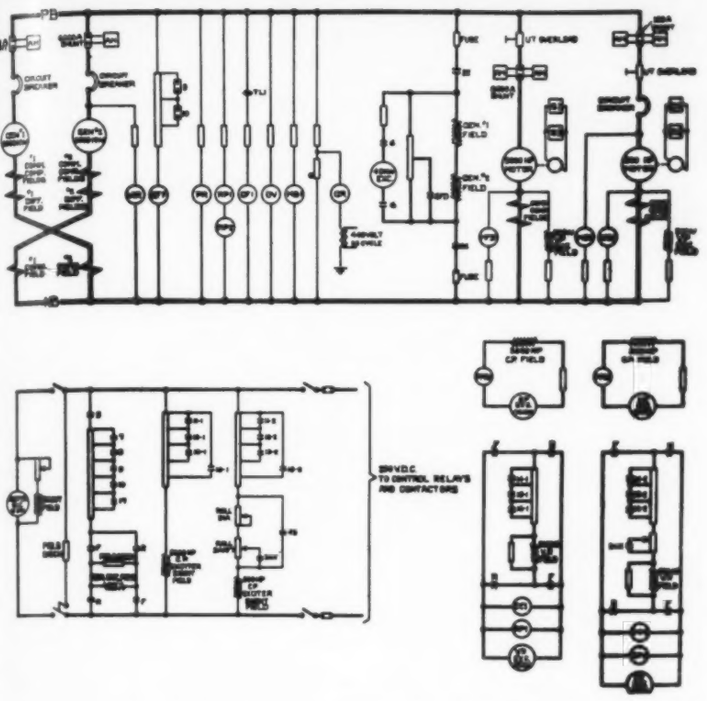
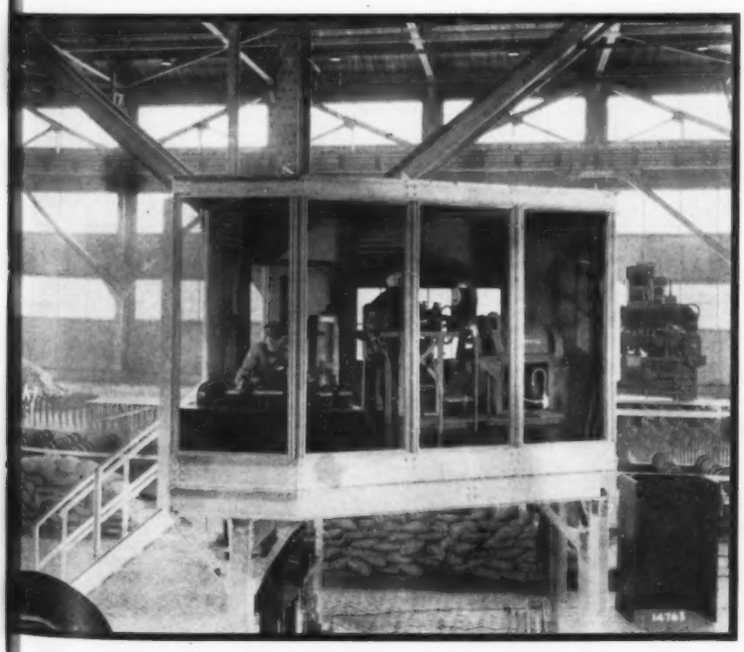


Figure 10 — Diagram of main and excitation circuits for reversing plate mill electrical drive.

proportioned to obtain the same relative rate of acceleration and thereby assure satisfactory operation when a long plate is in both mills at the same time. Rheostats

Figure 11 — View showing control pulpit for 110 in. reversing plate mill.



are also provided in the edger motor exciter field circuit, to permit adjustment of the edger speed to compensate for different roll diameters and for the different drafts which may be taken in the main mill.

c. The distance between the edging and main stands is 31 ft 4 in., and with this large separation, the two stands may almost be operated as separate units, the edging passes being made independently of the flat reducing passes. Under such operating conditions there is no need for one mill to accelerate to full speed when work is being done only in the other mill, and there has been provided in the mill control pulpit a selector switch. In the central position, both motors are accelerated to the speed determined by the main master switch, suitable for operation with a long plate in both mills. However in the left position, the edger motor is accelerated only to base speed while the main motor is accelerated to the full speed, and with the selector switch in the right position the main motor is accelerated only to base speed while the edger motor is accelerated to the speed determined by the main master switch.

Ventilation — The ventilation of the 5,000 hp and 500 hp reversing motors and 5,000 kw flywheel generator set, is by means of a downdraft air cooling and recirculating ventilation system. Air coolers are provided across each end of the motor generator set foundation, and along one side of the 5,000 hp motor foundation, to cool the air as it is discharged downward from the machines. The air from the motor generator set is returned to the motor room by two 40,000 cfm, 3 in. pressure fans, and from the reversing motors by two 27,500 cfm, 5½ in. pressure fans. Makeup air is supplied by a 20,000 cfm, 2 in. pressure fan. The screwdown motors and front and back mill table motors are also arranged for forced ventilation, the air for which is bled from the motor room, and blown to the motors by means of a 5,500 cfm, 10 in. pressure booster fan.

Mill Auxiliaries

Table I lists the various mill auxiliaries which are driven by 230 volt d-c and 440 volt a-c motors. From this tabulation it is noted that the 230 volt d-c auxiliary power load consists of 49 mill auxiliary motors totaling 2,325 hp and 22 motors on six cranes totaling 895.5 hp, making a grand total of 71 motors of 3,220.5 hp. The 440 volt a-c auxiliary power load consists of 61 motors, of from 1 to 100 hp totaling 820 hp. Of the direct current drives, the ten motors driving the leveler approach tables, roller leveler, leveler runout table, cooling conveyor tables, and transfer run-in table, are 3:1 range adjustable speed shunt wound, and the remaining drives utilize standard compound wound mill motors.

The control panels for the auxiliary drives on the reheating furnaces, reversing mill, and runout tables are housed in two auxiliary control houses, extending along the side and end of the motor room as shown on Figure 1. Controllers for the cooling conveyor tables, No. 2 transfer, tables, and pilers, are enclosed in sheet steel cabinets, and are installed on the mill floor in the line of building columns between the mill and finishing department buildings.

Characteristics of the six cranes serving the slab yard, motor room, mill building, and plate finishing and

TABLE I — 110 in. Plate Mill — Auxiliary and Crane Motors

Drive	250 v d-c		440 v a-c	
	Number of motors	Total hp	Number of motors	Total hp
Furnace pusher	2	150	.....	.....
Furnace depiler	2	30	.....	.....
Furnace discharge doors	.....	.....	2	15
Furnace exhaust fan	.....	.....	1	60
Furnace fuel oil pumps	.....	.....	2	15
Furnace control oil pumps	.....	.....	2	4
Furnace water booster pump	.....	.....	1	30
Furnace discharge table	1	50	.....	.....
Mill approach tables	2	100	.....	.....
Vertical edges adjustment	2	100	.....	.....
Slab turnarounds	2	20	.....	.....
Sideguards	4	40	.....	.....
Screwdown	2	150	.....	.....
Front and back main tables	4	400	.....	.....
Roll changing rig	1	25	.....	.....
Mill runout and shear approach tables	3	150	.....	.....
Upcut dividing shear	1	50	.....	.....
Shear balance pump	.....	.....	1	2
Shear runout tables	2	100	.....	.....
Plate transfer — Main	2	150	.....	.....
Plate transfer — Auxiliary	2	30	.....	.....
Plate transfer — Clutch	.....	.....	1	5
Plate transfer — Adjustment	.....	.....	1	10
Leveler approach tables	2	100	.....	.....
Roller leveler — Main	1	135	.....	.....
Roller leveler — Screwdown	1	10	.....	.....
Roller leveler — Oil pump	.....	.....	1	1
Leveler runout table	1	40	.....	.....
Cooling conveyor tables	5	200	.....	.....
Transfer run-in table	1	50	.....	.....
Plate transfer	1	35	.....	.....
Transfer adjustment	.....	.....	1	5
Transfer runout table	1	50	.....	.....
Dividing shear approach table	1	35	.....	.....
Dividing shear	.....	.....	1	100
Dividing shear runout table	1	50	.....	.....
Plate piler	1	25	.....	.....
Resquaring shears	.....	.....	2	200
Scrap shears	.....	.....	2	30
Circle cutting shear	.....	.....	1	3
Scale pit pump	.....	.....	1	40
Roll balance pump	.....	.....	1	30
Descaling system air compressor	.....	.....	1	25
Ventilating fans	.....	.....	8	161
Lubricating system pumps	.....	.....	15	42
Sump pumps	.....	.....	4	6
Roll lathe	1	50	.....	.....
Miscellaneous	.....	.....	12	36
Slab yard crane	4	181.5	.....	.....
Slab yard gantry crane	3	145	.....	.....
Motor room crane	4	109	.....	.....
Mill building crane	4	194	.....	.....
Plate finishing crane	4	181.5	.....	.....
Plate finishing crane	3	84.5	.....	.....
Total	71	3220.5	61	820

shipping building, are listed in Table II. Of particular interest is the 7½ ton, 30 foot span, semi-gantry magnet crane, which runs along one side of the slab yard over the scarfing and conditioning beds. This small crane is quite efficient in handling single slabs to and from the scarfing and deseaming beds, and releases the large overhead crane for the heavier work of transferring heavy lifts of slabs from incoming railroad cars, and to the reheating furnace depilers.

Master Control of Reversing Plate Mill

Figures 1 and 2 indicated the location of the control pulpit opposite the table between the main and edging mills, and Figure 11 shows more of the details of the arrangement of the master switches in the pulpit.

The mill is controlled by two operators in the elevated glass enclosed main pulpit, together with certain auxiliary control by the roller or gauger from an auxiliary control stand on the mill floor at the delivery side of the main stand.

The main operator's chair and control stand are elevated about two feet above the floor of the pulpit, and are turned at an angle to the mill axis so that the operator faces directly toward the entry side of the main horizontal mill. This operator manipulates the main drive master switch with his right hand and the main horizontal mill screwdown master switch with his left hand, and additionally has master switches to operate one screwdown motor independently to level the rolls, and to select either the edger or main motor to operate only at base speed when rolling in the other mill, and a rheostat to adjust the edger motor speed to match that of the main motor when rolling long plates in both mills at the same time.

The auxiliary operator's chair and control stand are at the pulpit floor level, and are arranged so that the operator faces the front mill table. The main table master switch, directly in front of the operator, controls the front and back mill tables, and by means of a selector pushbutton station may also control the mill approach and runout tables. When not connected to the main table master switch, the approach and runout tables may be controlled from their individual master switches, the approach table master switch being in the main pulpit at the operator's right, and the runout table master switch being in the shear and transfer control pulpit. The auxiliary operator also has master switches to control the furnace discharge table, edging mill adjustment, entry side slab turnaround, and entry sideguard adjustment, and foot operated switch to control the high pressure water descaling spray.

An auxiliary control stand is installed on the mill floor at the delivery side of the main horizontal mill, at which position the roller or gauger has master switches to control the delivery side slab turnaround, delivery sideguard adjustment, and inching of the rear mill table to spot the slab on the turnaround. Initially the delivery sideguard adjustment and slab turnaround were controlled from the main pulpit, but several month's experience has shown that they can be better controlled from the control stand at the delivery side of the mill.

Mill Output and Power Requirements

The 110 in. reversing plate mill rolls an extremely wide range of plate products. Sheared plate from 3/16 in. to 1 in. thick, and from 36 in. to 96 in. wide, is rolled from slabs ranging from 4 in. to 7 in. thick, 24 in. to 42 in. wide, and 56 in. to 85 in. long. Some heavy torch-cut plate up to 5 in. maximum thickness is rolled from slabs which are usually from 7 in. to 12 in. thick. Some plate products can be rolled directly from slab ingots. These ingots are about 56-60 in. long, average about 12 in. thick, and range from 26 in. to 42 in. wide, with weight of 4,500 to 7,500 pounds.

Tables III to VII are typical rolling schedules for various products rolled on the mill. It will be noted that drafts of from ¾ in. to 1 in. are taken for the first several passes, and on plate ranging up to 70-80 in. wide the maximum main motor load is about 10,000 to

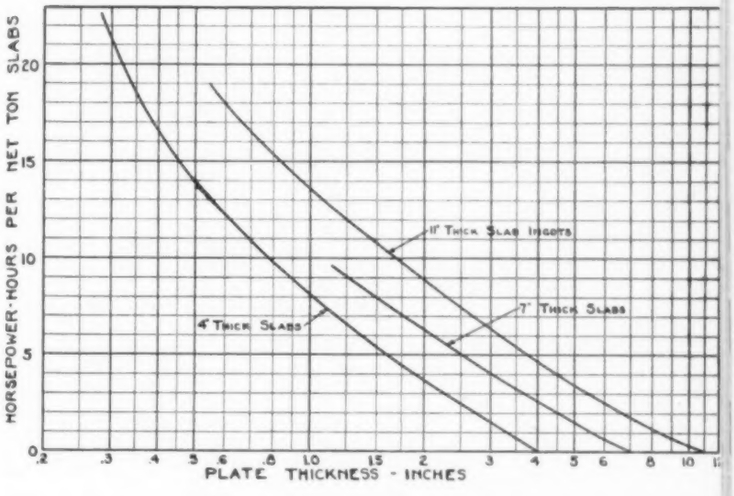


Figure 12 — Energy consumption curves for rolling plate on 110 in. reversing plate mill.

11,500 amperes, corresponding to 1,300,000 to 1,500,000 lb-ft torque, which is comfortably within the 1,700,000 lb-ft operating torque capacity of the motor.

During recent months, since the operators have become skilled in handling the mill, and the mill has been able to operate at full capacity, the monthly output has reached nearly 20,000 net tons of finished plate, and with favorable schedules this rate should be maintained, or bettered.

Over a six month period since operations have become well established the energy consumption of the 5,000 kw flywheel motor-generator set supplying power to the 5,000 hp and 500 hp reversing mill motors averaged 21.2 kwhr per net ton of slabs, or 27.7 kwhr per net ton of finished plate, and during the best month these figures were 20.0 and 26.7 kwhr per net ton of slabs and finished plate, respectively.

Over the same six month period, the energy consump-

TABLE II — 110 in. Plate Mill — Overhead Electric Traveling Cranes

	Hoist capacity		Span, ft-in.	Number of motors	Total hp
	Main	Auxiliary			
Slab yard	25	15	96-0	4	181.5
Slab yard (semi-gantry)	7½	..	30-0	3	145
Motor room	50	15	46-0	4	109
Mill building	50	15	86-0	4	194
Plate finishing — shipping	25	15	96-0	4	181.5
Plate finishing — shipping	10	..	96-0	3	84.5
Total				22	895.5

TABLE III

Rolling 11 in. x 42 in. x 56 in. — 7300 lb Slab Ingots to 84 in. Wide x .61 in. Thick Plate — 15 Passes

Pass number	Width, in.	Thickness, in.	Draft, in.	Main motor amperes
1	42	8.93	2.07	10,100
Turn				
2	69	7.88	1.05	10,200
3	69	6.91	.97	10,200
4	69	6.10	.81	7,900
5	69	5.15	.95	10,600
6	69	4.35	.80	7,700
7	69	4.26	.09	3,900
Turn				
8	88	3.50	.76	10,000
9	88	2.75	.75	9,600
10	88	2.00	.75	10,600
11	88	1.60	.40	7,900
12	88	1.19	.41	7,450
13	88	.88	.31	6,850
14	88	.68	.20	5,750
15	88	.61	.07	4,200

TABLE V — Rolling 7 in. x 42 in. x 72 in. — 6000 lb Slabs to 76 in. Wide x 1 3/16 in. Thick Plate — 9 Passes

Pass number	Width, in.	Thickness, in.	Draft, in.	Main motor amperes
Edge	40½	7	1.50	.....
1	40½	6.98	.02	1,700
Turn				
2	75	6.19	.79	8,650
3	75	5.40	.79	8,150
4	75	4.52	.88	8,150
5	75	3.72	.80	6,500
Turn				
6	76	2.91	.81	7,800
7	76	2.16	.75	8,900
8	76	1.56	.60	7,650
9	76	1.19	.37	6,230

TABLE IV

Rolling 11 in. x 30¼ in. x 56 in. — 5300 lb Slab Ingots to 95 in. Wide x .56 in. Thick Plate — 15 Passes

Pass number	Width, in.	Thickness, in.	Draft, in.	Main motor amperes
1	30¼	8.83	2.17	8,150
Turn				
2	70	8.36	.47	6,100
3	70	7.36	1.00	9,750
4	70	6.36	1.00	10,600
5	70	5.41	.95	11,300
6	70	4.55	.86	11,500
7	70	3.76	.79	11,800
8	70	3.28	.48	7,200
9	70	2.72	.56	7,000
Turn				
10	98	2.15	.57	10,900
11	98	1.62	.53	9,000
12	98	1.09	.53	9,600
13	98	.84	.25	6,750
14	98	.61	.23	5,800
15	98	.56	.05	4,000

tion of all of the remaining equipment, metered at 13,200 volts, and including the exciter set, descaling pump, air compressor, lights and all 250 volt d-c and 440 volt a-c auxiliaries, averaged 40.9 kwhr per net ton of slabs, or 53.3 kwhr per net ton of finished plate. During the best month these values were 37.0 and 49.3 kwhr per net ton of slabs or plate, respectively.

Extensive graphic meter tests have been conducted to establish the performance of the electrical equipment when rolling on different typical schedules, and the data from these tests has been used to prepare the energy consumption curves shown on Figure 12. The upper curve is the average of two tests rolling 11 in. thick slab ingots to 84 in. wide by .61 in. thick plate, and to 95 in. wide by .56 in. thick plate, respectively, making 15 passes in the main mill stand. The middle

TABLE VI — Rolling 4 in. x 36 in. x 62 in. — 2530 lb Slabs to 76 in. Wide x .30 in. Thick Plate — 9 Passes

Pass number	Width, in.	Thickness, in.	Draft, in.	Main motor amperes
Edge	34	4	2.00	1,050*
1	34	3.46	.54	4,700
Turn				
2	76	2.50	.96	8,650
3	76	1.72	.78	8,150
4	76	1.13	.59	7,700
5	76	.75	.38	6,500
6	76	.53	.22	4,600
7	76	.40	.13	4,100
8	76	.32	.08	3,400
9	76	.30	.02	1,200

*Edger motor.

curve is for a test rolling 7 in. thick x 42 in. wide x 72 in. long, 6,000 pound slabs to 76 in. wide by 1 3/16 in. thick plate, making a heavy scale breaking pass in the edging mill, and 9 flat passes in the main mill. The lower curve is the average from several tests rolling 4 in. thick slabs to .30-.33 in. thick by 67-76 in. wide plate, making a heavy (2 in.) scale breaking pass in the edging mill and 9 flat passes in the main mill. These curves check reasonably well with test data from other plate mills and the roughing stands of hot strip mills, and should be of particular interest at this time when a number of large plate mills are in progress of design and construction.

TABLE VII—Rolling 4 in. x 32 in. x 60 in.—2175 lb Slabs to 67 in. Wide x .30 in. Thick Plate—9 Passes

Pass number	Width, in.	Thickness, in.	Draft, in.	Main motor amperes
Edge	30	4	2.00	950*
1	30	3.82	.18	3,100
Turn				
2	67	2.94	.88	6,500
3	67	2.15	.79	6,500
4	67	1.46	.69	7,200
5	67	.97	.49	6,700
6	67	.59	.38	5,500
7	67	.39	.20	4,800
8	67	.31	.08	3,600
9	67	.30	.01	1,000

*Edger motor.

DISCUSSION

PRESENTED BY

C. C. WALES, Vice President and Director, Hamilton Bridge Company, Ltd., Hamilton, Ontario

A. F. KENYON, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

C. C. WALES: For those who perhaps are not familiar with the operations of the company which Mr. Porter represents, I might say that the Steel Company of Canada is perhaps by far, for its size, the most diversified steel company on this continent. This is not by accident; it is the result of deliberate, careful, conservative, thorough planning over a great many years.

Back in 1926 a semi-continuous strip mill was built at Butler, Pennsylvania, using a universal mill for roughing. Since that time most all other strip rolling mills have been strictly of the continuous type, although universal roughing is used on the Carnegie-Illinois mill at Homestead; this, however, is not strictly speaking a strip mill, but rather a continuous plate mill.

The new mill of the Steel Company of Canada now represents the first steps toward a strip mill with capacity for roughing slabs to be later finished in hot strip gauges, the roughing stand being of itself a plate mill capable of rolling a wide variety of plate gauges and widths. The Steel Company of Canada, in laying out this mill, has taken full advantage of the most modern practice, and has further built the mill so as to make it most able to serve a limited Canadian market. It is fortunate for the Canadian war effort that this mill was conceived and installed at a time in the history of Canada when it was most needed. Allow me to assure you that this mill is playing a very important and very vital part in the service of Canada, Canadian war effort and the cause of the United Nations.

A. F. KENYON: I do not have anything to add to Mr. Porter's presentation of the paper except to emphasize certain factors involved in the selection of the electrical drive equipment.

1. *Speed of the reversing motor* — Some similar mills have selected the main reversing motor with considerably higher base speed, even as high as 50 rpm. However for this mill, detailed analysis of extensive power calculations and time studies for the expected range of rolling schedules indicated relatively small increase in output with a higher speed motor, and the lower horsepower and less expensive 5,000 hp, 35/80 rpm motor was selected.

2. *Capacity of motor generator set* — The 5,000 hp rating of the induction motor driving the flywheel motor generator set is larger than usually provided for a 5,500 hp reversing mill drive, but will be quite necessary for the ultimate operation of rolling long universal plate and breakdown bar for strip.

Use a Cable that Does the Job

WITHOUT

WASTING COPPER

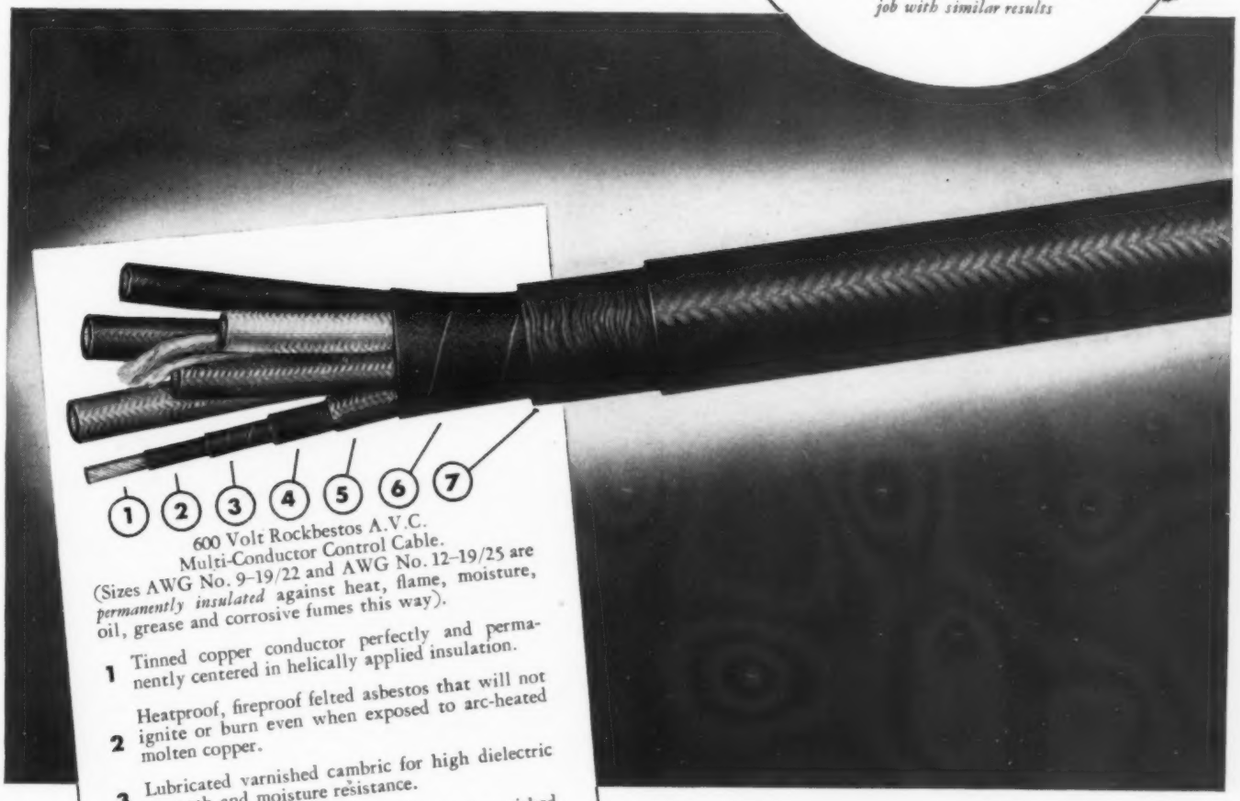
You can save copper *when you order* wire and cable; *pounds*, perhaps *hundreds of pounds*, probably as much as *a ton or more*, —you can help spread our rapidly diminishing copper supply farther—and you can do it by specifying smaller conductors that will still be adequate for normal operating requirements.

To the right is but one example of what can and should be done more often to further copper conservation.

3806 LBS. OF COPPER SAVED ON A SINGLE JOB

A large mill had habitually bought Rockbestos A.V.C. Multi-Conductor Control Cable in size #9 AWG—19/22 strand conductors. They had a requirement for 16,000 ft. of 12 conductor cable. Our engineer asked, "Do you actually have to use a #9 conductor? Wouldn't #12—19/25 strand conductors amply carry your control circuit?" Customer investigated, decided he could make the change—result: a saving of 3806 pounds of copper while still having ample current carrying capacity.

Our engineers may be able to analyze your job with similar results



600 Volt Rockbestos A.V.C. Multi-Conductor Control Cable.
(Sizes AWG No. 9–19/22 and AWG No. 12–19/25 are *permanently insulated* against heat, flame, moisture, oil, grease and corrosive fumes this way).

1. Tinned copper conductor perfectly and permanently centered in helically applied insulation.
2. Heatproof, fireproof felted asbestos that will not ignite or burn even when exposed to arc-heated molten copper.
3. Lubricated varnished cambric for high dielectric strength and moisture resistance.
4. Another felted asbestos wall to seal the varnished cambric away from heat, flame and oxidation.
5. Color-coded cotton braid for easy circuit identification.
6. A wrapping of moisture-proof tape to bind the cabled conductors and jute filler together.
7. A tough, rugged asbestos braid impregnated with inert compounds that are resistant to heat, flame, moisture, oil, grease and corrosive fumes.

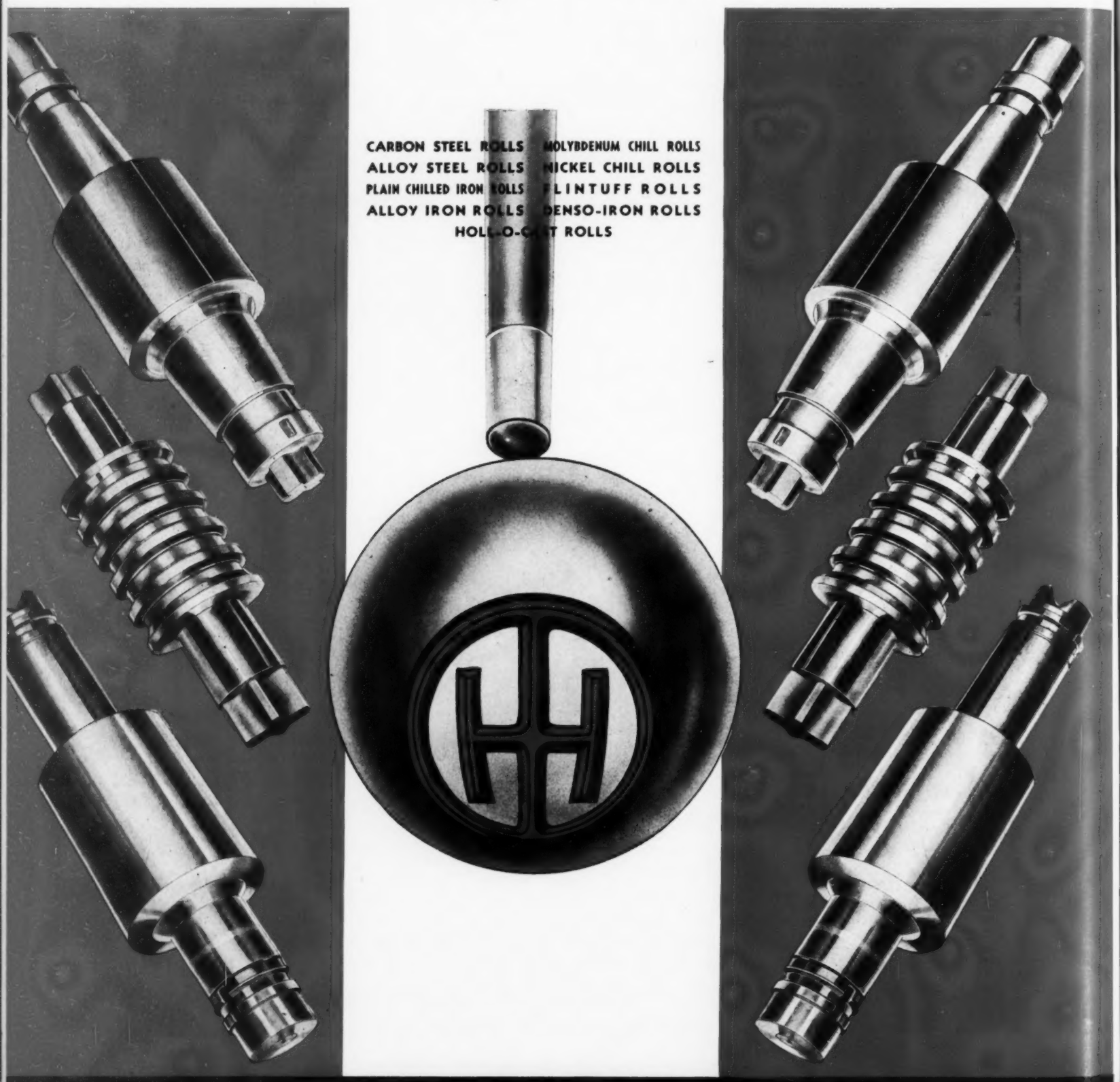
Copper can be saved safely on many jobs with Rockbestos A.V.C. (asbestos and varnished cambric insulated) Underwriters' Type AVA, and Rockbestos All-Asbestos, Underwriters' Type A1, wires and cables. Their heatproof, fireproof insulation in many instances gives you greater carrying capacity because it can be run hotter (Type AVA, 110°C.–230°F., Type A1, 125°–257°F., N.E.C. page 286). These constructions are resistant to heat and moisture, oil, grease, flame and corrosive fumes, will not bake brittle, bloom, burn or rot. For recommendations on your specific cases and samples write to Rockbestos Products Corporation, 869 Nicoll Street, New Haven, Connecticut.

The Wire with Permanent Insulation **ROCKBESTOS A.V.C.**

NEW YORK • BUFFALO • CLEVELAND • CHICAGO • PITTSBURGH • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • PORTLAND, ORE. • SEATTLE

OHIO ROLLS

have something extra on the ball



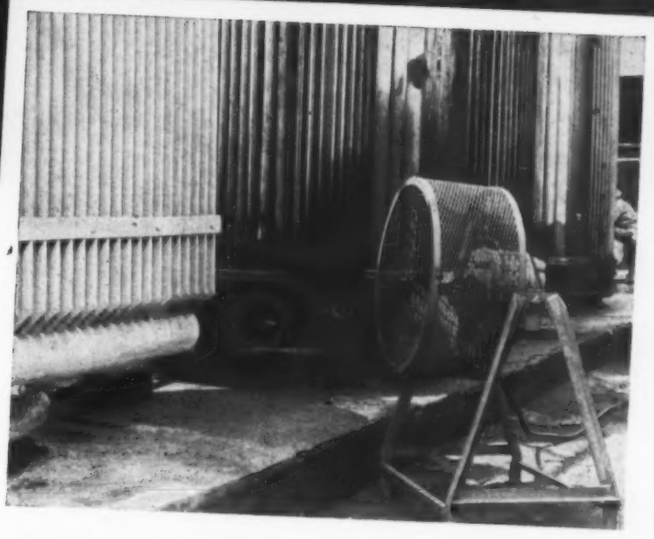
THE OHIO STEEL FOUNDRY COMPANY

LIMA *and* SPRINGFIELD, OHIO

Let Truflo Fans . . .

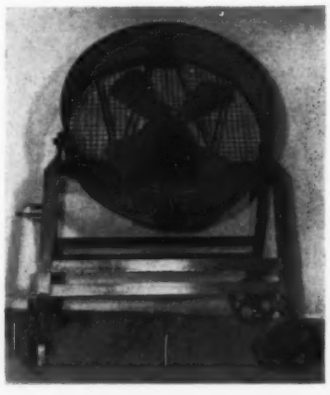
Help keep your workmen on their toes

Portable Fan No. TF-100, recognized as standard in many of the country's largest mills. Sizes from 12 in. to 36 in. in diameter.



Portable Fan No. TF-300 in operation, cooling large transformers in strip mill.

Crane Cab Fan, for cooling crane cab interiors and other confined areas. Available in 12 in. and 18 in. sizes, adjustable both horizontally and vertically.



Portable Fan No. TF-300W. Angle iron support adjusts for vertical or horizontal discharge through almost 360°.

It's more important now than ever before to keep your workmen comfortable. For comfortable workmen are more efficient, produce more work in a given time.

Truflo Fans can help you keep your workmen on their toes. All Truflo Fans are designed and built correctly for efficient, economical operation — they move more air per dollar. Write for free literature on any of the following styles:

Portable Cooling Fans • Crane Cab Fans
Wall Fans • Exhaust Fans • Blowers
Roof Ventilating Fans • Pent House Fans

TRUFLO

554 MAIN STREET HARMONY, PA.

INDUCTION HEATING FOR TIN REFLOW

▲ Because the tin coating produced by the electrolytic tinning process is of a gray, rather porous matte character, it is desirable to reflow the coating to obtain a smooth, polished surface which offers increased corrosion resistance. Reflowing has been accomplished by passing the tinned strip through a hot oil bath or a radiant tube furnace, by electrical conduction heating, or, more recently, by electrical induction heating. A temperature of 452 F is used for reflowing the tin coating.

Induction heating as developed by Westinghouse Electric and Manufacturing Company has been applied to one commercial electrolytic tinning line, and a number of additional units are under construction. The process is extremely rapid, requiring only 10-12 ft length of inductor coil for strip speeds up to 1000 fpm.

The reflow process may therefore be incorporated into the electrolytic tinning line. The inductor heater coil is rectangular in form, wound as close to the strip as mechanically possible. It acts as the primary of a transformer, while the strip itself constitutes a single turn secondary in which the induced current generates the desired heat.

For usual tinplate gauges (.008-.011 in.) a frequency of about 200,000 cycles per second seems most practical. As rotating machinery is not practical above 15,000 cycles per second, power is supplied by vacuum tube oscillators which are essentially the same as the transmitter of a radio station. Sixty cycle alternating current is rectified to direct current and fed to the oscillator tubes where it is converted to the high frequency current and sent out through the inductor heater coil. Power input may be rapidly adjusted to accommodate changes in strip speed. Based on a speed of 1000 fpm, an oscillator of 1200 kw input is required, which requires about 2300 kw of power input.

This development was first announced to the industry at a meeting of the Pittsburgh District Section of the Association of Iron and Steel Engineers, November 9th, in a paper presented by G. E. Stoltz. This paper, giving complete details of the process will be published in the near future in the Iron and Steel Engineer.

D-c power at 17,000 volts is converted to 200,000 cycle a-c power in this 100 kw vacuum oscillator which supplies power for tin reflowing by induction heating in a laboratory set-up.

SCRAP DISCUSSED AT GUILD MEETING

▲ According to the operators of electric furnaces, the primary difficulty besetting their efforts to increase production of the critical electrical grades of steel is the much discussed scrap situation. In common with other steel makers, they are experiencing a growing shortage of suitable scrap. This is particularly true of the electric furnace shop which is not part of a large, integrated steel plant.

This difficulty, with its possible remedies, was the principal topic of discussion at a sectional meeting of the Electric Metal Makers Guild held October 31st in Pittsburgh, Pennsylvania. Harry F. Walther, Timken Roller Bearing Company and Guild president, presided over the meeting, and the discussion was led by Harry McQuaid and A. F. Danzer of the War Production Board.

The discussion brought out the fact that inferior scrap supplies were a natural result of the general drop in

scrap quality, but that electric furnace shops might receive greater consideration in the way of allocation of the more desirable grades. Turnings bring the drawback of their mineral oil content, which boosts the carbon content of the bath. Crushed turnings seem to be more desirable from this standpoint than briquetted turnings. It was suggested that the removal of oil from turnings be encouraged by allowing the cost of the process to be added to the ceiling scrap price.

Plants having spectroscopic equipment for rapid analysis of the steel samples reported a gain of one-half to one hour per heat through its use. If this equipment were generally employed with similar results, a highly desirable increase of about 10 per cent might be expected from the existing electric furnaces.

LARGE TRANSFORMERS FOR ALUMINUM PLANT

▲ Employees of a Sharon war plant have completed the biggest job they ever tackled — building two electric transformers, each as big as a six-room house, to handle power for a new aluminum plant.

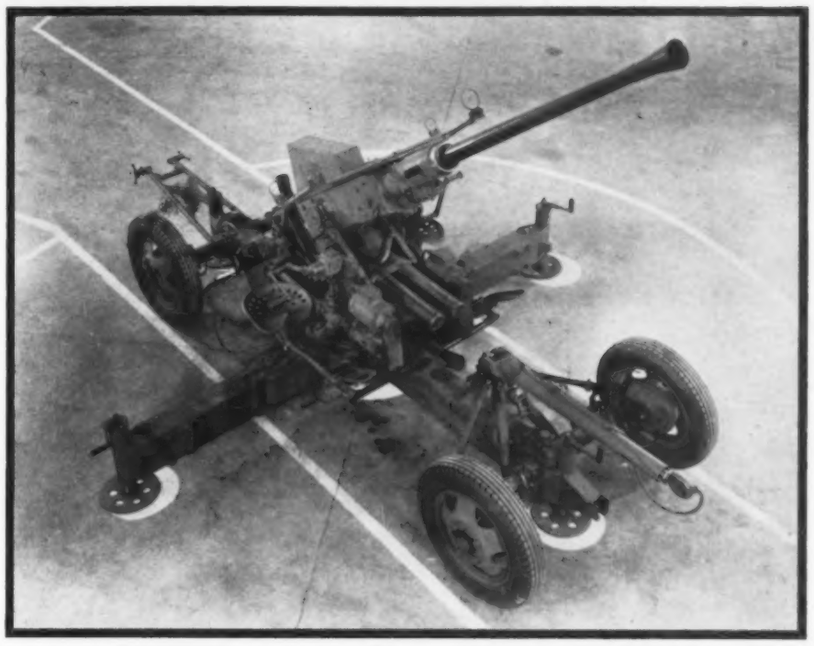
The 257-ton transformers, built at the Westinghouse Electric and Manufacturing Company's Division, have been delivered to a utility company to step up electric power from 27,000 to 132,000 volts.

This five-fold voltage increase provides the most efficient transmission of power between the generating station and the aluminum plant, explained W. G. James, manager of the Westinghouse large power transformer engineering section.

Construction of the transformers required about 188 tons of structural steel, 111 tons of special core steel and 130 miles of copper wire weighing 29 tons. Placed inside the transformer tanks to cool the electrical equipment and provide electrical insulation were 44,000 gallons of oil — enough to fill eight average railroad tank cars. Each transformer is 25 feet high, 39 feet long and 24 feet wide.

"Large as the transformers are," said Mr. James, "if they had been built prior to the recent development of a new core steel by Westinghouse, their construction would have required nearly 40 more tons of steel,

Gun Carriage Design Wins $11,200.00

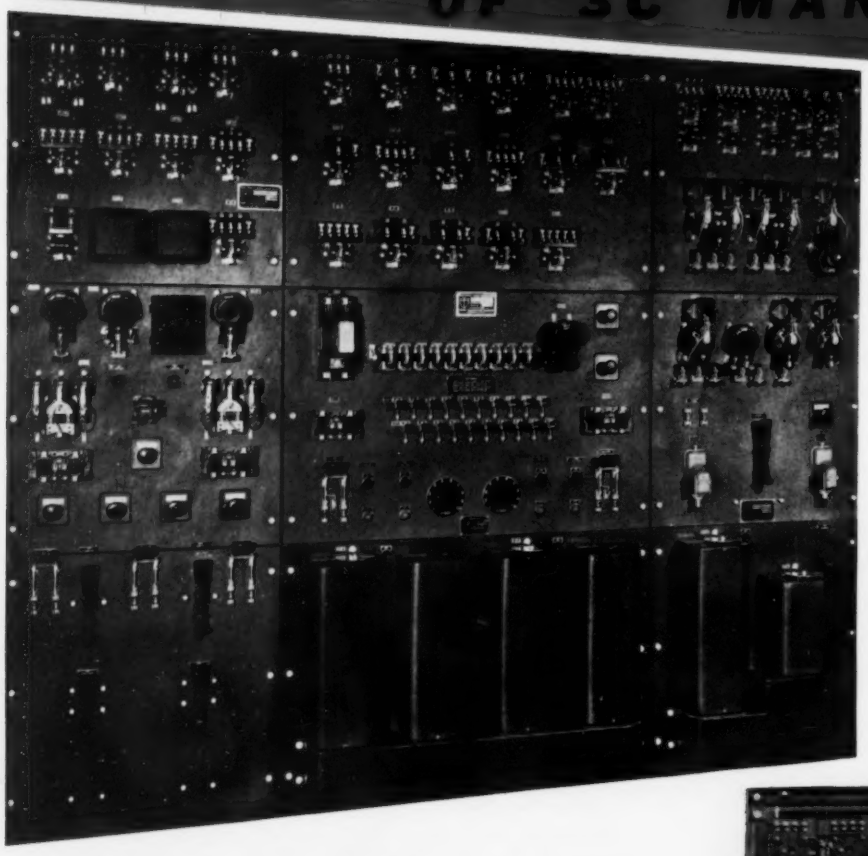


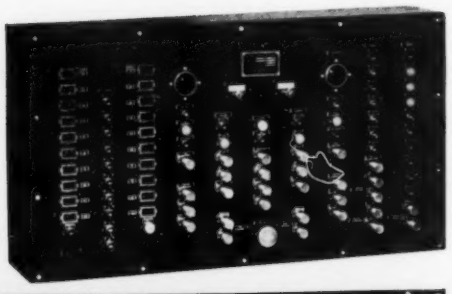
Shown here is the 40 mm Bofors anti-aircraft gun, the carriage of which was redesigned from riveted to welded construction and described in a paper which won the author, Dr. J. L. Miller, chief metallurgist, Gun-Mount Division, The Firestone Tire and Rubber Company, Akron, Ohio, the second grand award of $11,200 in the 2½ year $200,000 welding study program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

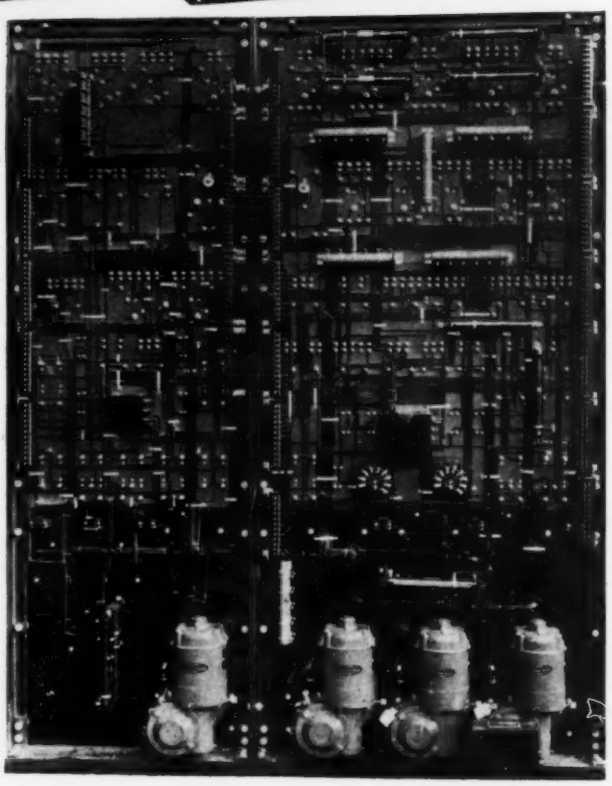
From Piano to Shell Machine

The deft fingers of Herbert James no longer glide back and forth along the keyboard of his favorite piano, for he is a music teacher turned war worker. He is pictured adjusting the tip of a tool used in machining shells at Christy Park Works of National Tube Company, U. S. Steel Subsidiary, where his idea for using an acetylene flame in attaching tips on tools has speeded production and conserved vital machining tools. The suggestion won for him the distinction of being first Pennsylvania war worker to win War Production Board's Certificate of Individual Production Merit.

TYPICAL FREYN DESIGN FURNACE CHARGING CONTROL OF "3C" MANUFACTURE







"MORE IRON! MORE SCRAP!"

That's the nation-wide cry in the steel industry—for without plenty of iron and scrap, all-out steel production falls off.

Typical of the Freyn Design—Clark Built Control apparatus, are the panels above. These provide accurate control for Blast Furnace Charging, Coke Control, Stock Line Recorder, and Distributor Control.

This, together with a "3C" designed and built Skip Hoist Control gives continuous and reliable operation.

The Push Button Panel is made up of "3C" Bulletin 100 Type "D" Push Button units.

Typical also of the neat wiring of this apparatus, is the rear view of this panel for Blast Furnace Charging and Coke Control.

"3C" apparatus is providing splendid service in steel mills everywhere.

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

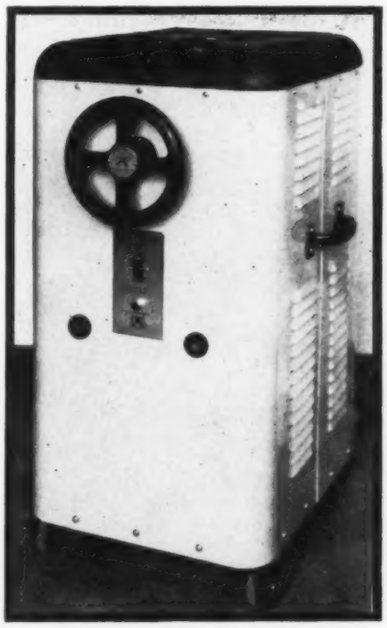
an additional four tons of copper and 6,000 more gallons of oil.

The new type core steel, called Hipersil, carries one-third more magnetic flux, or magnetism, than any steel formerly used for transformer cores. Because cores of Hipersil can be built smaller, less current-carrying copper wire is required to wind around them, and the steel tank containing the core, coils and insulating oil can in turn be made smaller.

More than 200 men played a part in the building of these two immense transformers, and the job took five months. It required six freight cars to ship each unit to its destination.

PRECISION CONTROL ON ARC WELDER

▲ The Hercules Electric and Manufacturing Company, Inc., Brooklyn, New York announce that its new line of variable core Herco arc welders are being favorably received in industry. Among the many features of this recently developed welder is the interesting precision heat control which enables the operator to get minute heat adjustments over the entire transformer range. Another important factor is the ability to operate twenty-four hours per day continuously, a boon for war plants working three shifts. The relative absence of "arc blow" permits the use of large diameter electrodes which means more metal deposited in less time and speeds production. This company will be very glad to supply any additional information upon request.



SAFETY AWARD TO REPUBLIC PLANT

▲ Two first place safety awards in the annual contest conducted by the National Safety Council were awarded to the Warren District of Republic Steel Corporation.

Formal presentation of the awards was made in Chicago on Tuesday, October 27, to Frank E. Flynn, district manager.

Republic's Warren plant took first place in the large steel mill classification which includes mills working 750,000 or more man hours per month. A total of 25 steel plants were included in this group.

Republic's Niles plant finished first in competition with 37 other companies in the medium sized finishing and fabricating mills group.

Since 1934 the Niles plant has received five first and two second awards in this national contest. Warren first place in 1938 and since then has been awarded two firsts, one second and two thirds.

With Mr. Flynn in Chicago was G. H. McClain, superintendent of Industrial Relations and H. H. McCorkle, safety supervisor.

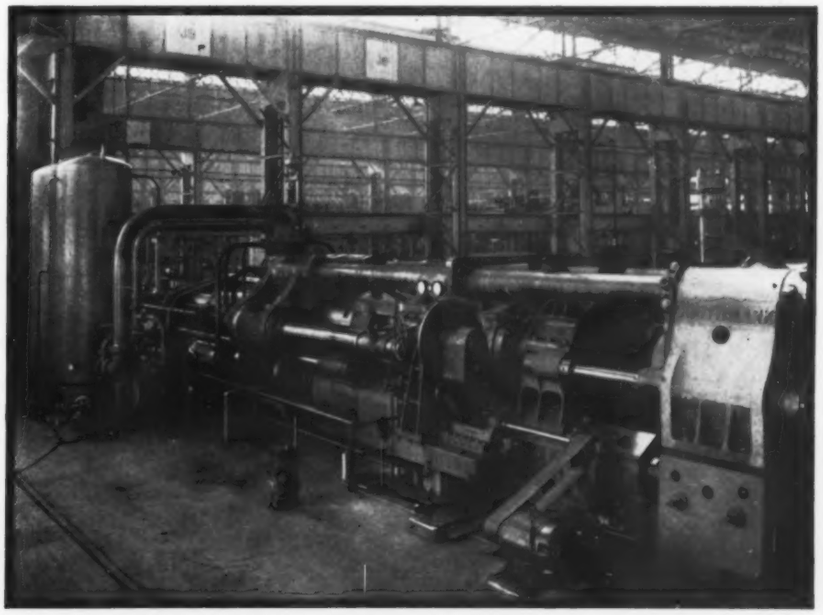
The Warren steel plant won first place with an accident frequency of 1.58 and had only 17 lost time injuries. Man hours worked totaled 10,753,734. The second placed plant had an accident frequency of 2.16 and the plant in last place finished with a frequency of 10.45.

The Niles record was perfect in that it had an accident frequency of .0, having had no lost time injuries during the contest period of one year ending June 30, 1942. During that year the company worked 1,228,146 man hours.

CALIFORNIA PROJECT TO BE EXPANDED

▲ Approval of a $26,000,000 addition to the steel plant facilities being built at Fontana, California, by the Kaiser Company, Incorporated, was announced recently by Donald M. Nelson, Chairman of the War Production Board.

One of Five Recently Completed



One of five, 3,500 tons extrusion presses recently completed by The Baldwin Southwark Division of The Baldwin Locomotive Works of Philadelphia. Designed for both direct and indirect extrusion, this powerful press is equipped with a 250-ton hydraulic billet shear, two coarse tooth saws driven by 40 horsepower motors and a billet handling device to take the heated billet from the furnace and deposit it in front of the extrusion container.

The press' main cylinder casting weighs 200,000 pounds, the machine proper 1,000,000 pounds and complete with auxiliaries 1,500,000 pounds. It is of the four-rod type, with forged tension rods 16 inches diameter.

The new facilities, expected to be completed in about twelve months, will add 225,000 tons of steel ingots, or 158,000 tons of finished products to the capacity of the plant. The facilities already under construction scheduled for completion during the first quarter of 1943 — will have a capacity of 450,000 tons of ingots, or 300,000 tons of steel plates.

All of the new steel to be produced will become part of the Nation's supply and, of course, will be subject to allocation in the usual way.

"Mr. Kaiser and his associates have been doing a fine job in all their war production projects," Mr. Nelson said, "and I am certain that the enterprise they have demonstrated will again be reflected in the building of this new steel capacity."

The facilities to be added include two open-hearth furnaces with a charge capacity of 185 tons each; a 28 inch structural mill fed by a 36 inch breakdown mill; a merchant and bar mill; alloy finishing facilities: and slow cooling pits for ingots.

Ingots of standard sizes and shapes of approximately 5,000 pounds to 12,000 pounds each will be produced. The announced expansion includes a further extension of ingot mould-making capacity.

The addition of the two open hearths will permit the Kaiser Company to make full use of all pig iron produced in the blast furnace now almost completed as a part of the original plans. The furnace will have a capacity of 1,200 tons of pig iron a day.

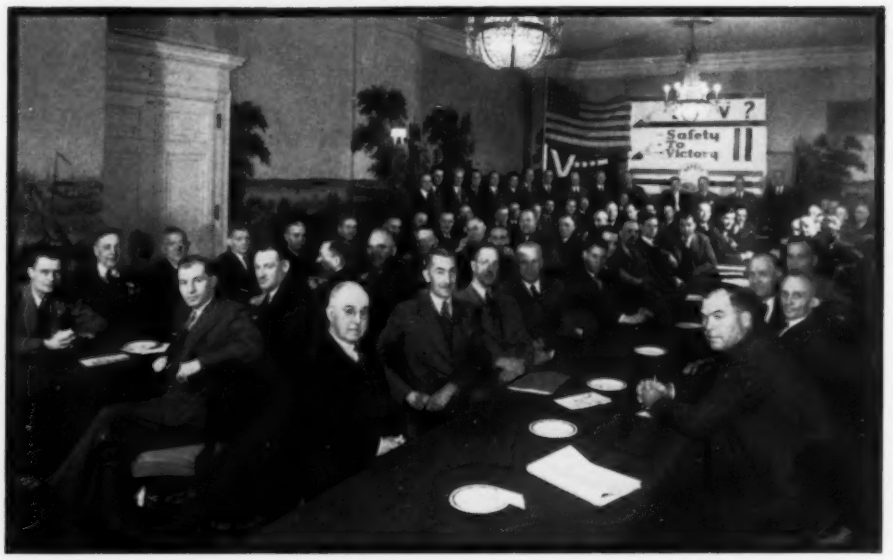
The larger part of the total output will be in those products most suitable for shipbuilding, although the present expansion contemplates the possibility of some alloy steel manufacture.

Production of the mill now being built at Fontana will consist entirely of steel plates. When the added facilities are in operation, the Kaiser Company will be producing, in addition, structural shapes and some amounts of other carbon steel products.

The iron ore for the blast furnace is being supplied from Southern California desert deposits. Coal is being obtained from mines in Utah, while limestone is supplied from quarries only a few miles from the Fontana plant.

The expansion has been recommended by WPB to the Reconstruction Finance Company for financing.

U. S. Steel Goes All Out For Safety



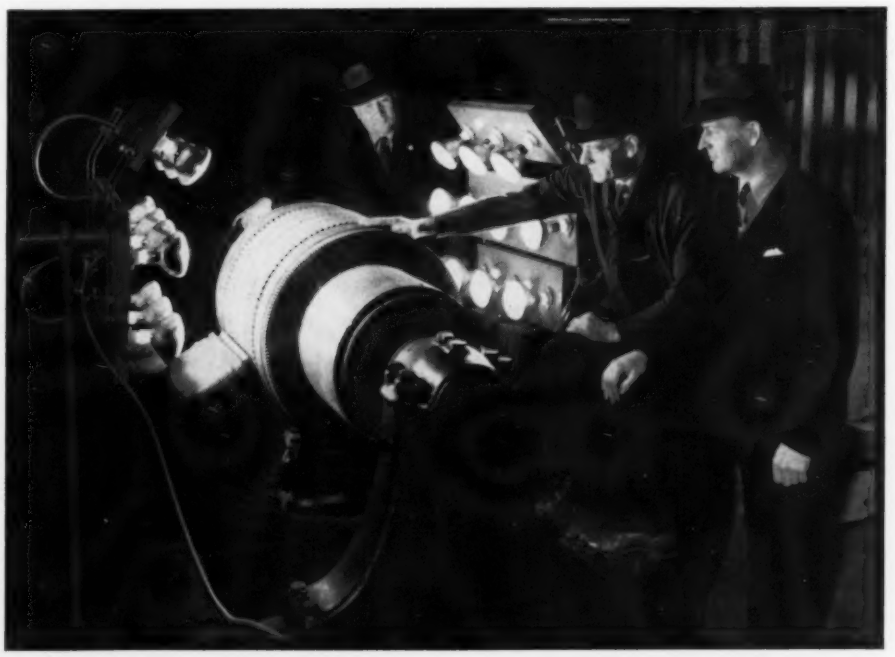
Eighty safety representatives of United States Steel Corporation subsidiaries as they met in Chicago, October 26, to complete arrangements for a war-time intensification of the corporation's accident prevention and industrial safety campaign to begin November 2.

The all out safety drive is in keeping with Mr. Fairless' statement that the conservation of manpower is essential to the continuance of record-breaking production of steel.

INFRA-RED HEATING SPEEDS MOTOR REPAIR

▲ Motor and generator reconditioning jobs that formerly required three days due to oven drying are now completed in eight hours by infra-red heating at the John D. Crawbuck Company plant, Monaca, Pennsylvania, according to Walter S. Crawbuck, electrical engineer. Other advantages are a financial savings of 50 per cent, simplification of work and the performance of repair jobs without the necessity of completely dismantling the equipment involved.

Infra-red is used at the Crawbuck plant to heat armatures, motors, etc., and to bake varnish. Two 10-unit



Time outages are reduced by using infra-red to reconditioned coils in motors and armatures. This portable drying unit composed of twelve 250-watt R-40 bulb Westinghouse drying lamps enables the John D. Crawbuck Company plant, Monaca, Pa., to reduce drying time of this 300-horsepower mill motor from three days down to eight hours.

lamp banks on adjustable stands are used for drying motor and generator rotors, and a 12-unit bank is set inside the reconditioned stators. Lamps used are the Westinghouse 250 watt R-40 bulb type with built-in reflectors.

By the old method it was necessary to dismantle large motors and generators for reconditioning at the Crawbuck Company plant since the drying ovens were not portable. With infra-red, the portable radiant heat unit may be taken to the object — a particularly desirable practice in the case of 300- or 400-horsepower motors and repairs are made on the job, resulting in large savings in time and man hours.

In drying the windings the temperature is raised very carefully to preserve the life of the insulation. The infra-red radiation sets up the required temperature in the windings, thus eliminating the extraction of parts. Temperature is regulated and a further improvement is the installation of a thermostatic control to disconnect the lamps when the coils have been properly dried.

FLYWHEEL REPAIRED BY ELECTRIC WELDING

▲ Much has been written praising the enviable steel production records earned by workers in steel factories. But little has been directed toward the maintenance men in these plants — the men who in large part make these production records possible.

A typical example of their work is the repair of this half ton cast iron flywheel at the Inland Steel Company, Indiana Harbor, Indiana. The wheel, an urgently needed special job, was dropped unfortunately during shipment and broken. Getting a new wheel would have taken months.

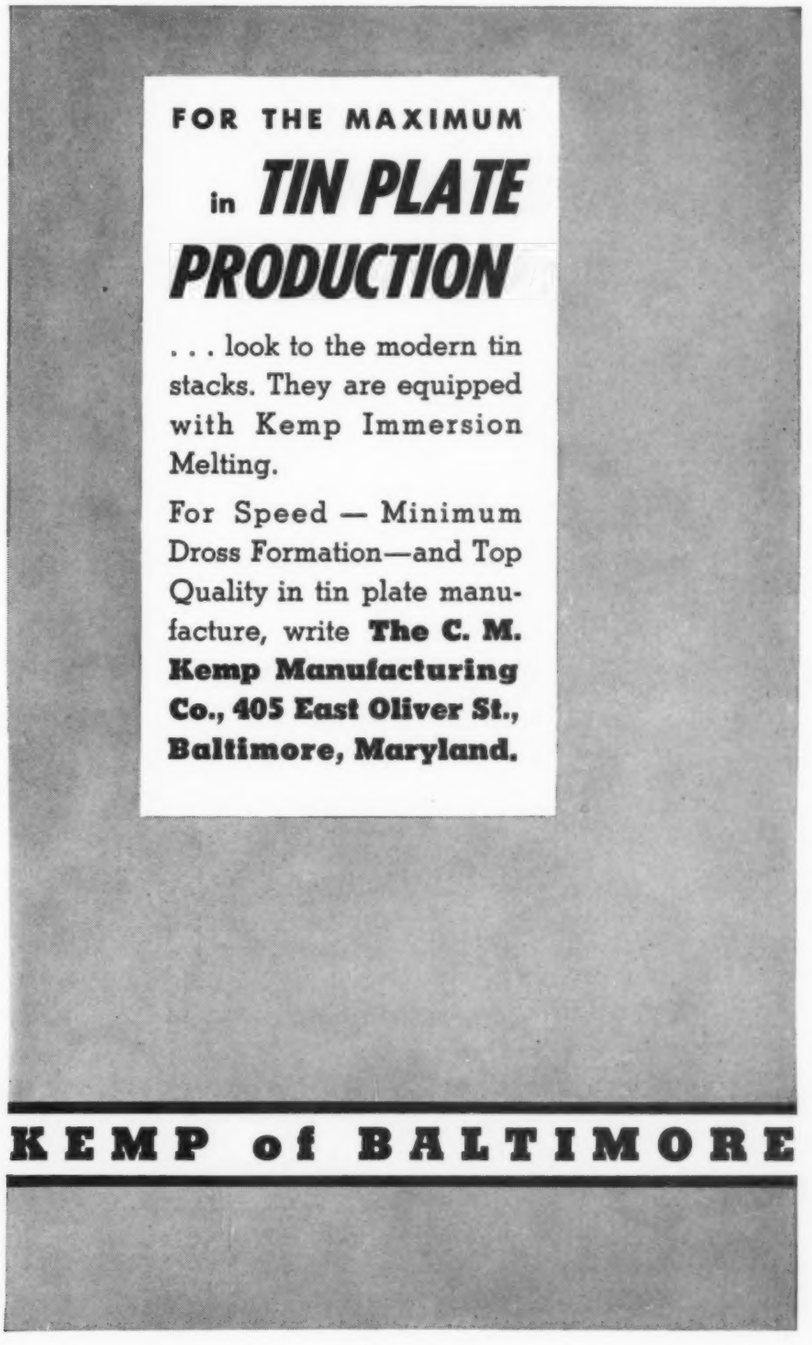
Company maintenance men, however, prepared the wheel and spoke for welded repair. The breaks were welded easily with cast iron electrodes — and the flywheel was ready for use four hours after the break was discovered. Incidentally, a new wheel would have cost $1,000. The welded repair, including finishing time, was only $4.90.

Electric welding put this flywheel back in repair in four hours, saving about $1000.

MORE PRODUCTION RECORDS FOR C-I

▲ War-busy furnaces of Carnegie-Illinois Steel Corporation in the month of October produced more iron and steel than at any time in the history of this U. S. Steel Corporation subsidiary.

With individual all-time records, 6 blast furnaces and 3 open hearth shops in the Pittsburgh district of


FOR THE MAXIMUM
in TIN PLATE
PRODUCTION
. . . look to the modern tin stacks. They are equipped with Kemp Immersion Melting.
For Speed — Minimum Dross Formation—and Top Quality in tin plate manufacture, write The C. M. Kemp Manufacturing Co., 405 East Oliver St., Baltimore, Maryland.
KEMP of BALTIMORE

Carnegie-Illinois contributed greatly to the production of 1,460,102 net tons of iron and 1,936,489 net tons of steel ingots and castings.

Record-breaking blast furnaces in the Pittsburgh district are the No. 1 and No. 3 stacks at Clairton, Isabella No. 1 and No. 3 and Duquesne Works' blast furnaces No. 2 and No. 5.

In the steel-producing division, open hearth shops contributing individual all-time records in the Pittsburgh district are located at Duquesne Works and the Lorain Division in Johnstown.

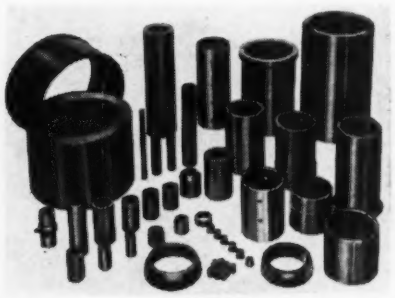
Three blast furnaces and a merchant mill at Gary Works established new monthly highs. At the South Chicago Works the Number 1 blast furnace topped its best previous record established in August and the electric furnace department established 3 new records representing an increase of almost a thousand tons over the record made in July.

Carnegie-Illinois steel men, harvesting twenty-two all-time records in furnace production alone, exclusive of all rolling mill operations, made it possible for the company to maintain melting activities at well over 100 per cent throughout the month.

FABRIC REPLACES CRITICAL METALS

▲ Shortage of critical bearing metals is being overcome and performance results greatly improved through the use of oil-lubricated non-metallic moulded bearings, developed by the Gatke Corporation, 228 N. La Salle Street, Chicago.

Known as Lubritex bearings, these bearings are distinctly different from Gatke Hydrotex (water-lubricated) and Gatke Grafitex (self-lubricated) bearings in that they are made of various material combinations developed especially to meet all kinds of service conditions using grease or oil lubrication.



Gatke Lubrites bearings are replacing conventional bearings for highly satisfactory results on all kinds of service.

According to the manufacturer, Gatke Lubritex bearings are replacing conventional bearings with highly satisfactory results on all kinds of service. They stand up under impact loads that are too great for metal bearings — have much greater wear life and lower friction. Lubrication is much less critical — they do not score journals, even if lubrication fails for limited periods.

These unique non-metallic bearings are engineered for the application and moulded to finished dimensions in all shapes and sizes for replacing metal bearings.

Performance results on a wide range of service conditions are described in a recent catalog.

HAYS
GAS-AIR
RATIO CONTROLLER

Automatic
COMBUSTION
CONTROL
for SOAKING PITS
SLAB HEATING, RE-HEATING FURNACES, ETC.

PRESSURE CONTROL—control of heat input or complete combustion control are offered by HAYS to help produce MORE steel, BETTER steel at lower cost. Hays engineers are at your disposal in securing quick action in applying partial or complete control as your need demands. Get in touch with the nearest Hays representative or write the factory direct.

For Oil Fired Furnaces—Publication 42-527
For Gas Fired Furnaces—Publication 42-526
For Pressure Control—Publication 42-530

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

RECEIVES CONTRACT FOR DETINNING EQUIPMENT

▲ Blaw-Knox Company has been awarded a contract amounting to approximately $1,000,000, by the H. K. Ferguson Company, for the design and fabrication of 14 new type detinning drums for use in salvaging tin from cans. This contract represents a part of that awarded recently to the Ferguson Company by the Defense Plant Corporation for six detinning plants for salvaging cans.

The drums will be cylindrical in design, each with a diameter of 20 feet, and a length of 28 feet. Shredded tin cans will be fed into one end of the drum and, after passing through a chemical solution which is kept in motion by rotation of the drum, will emerge at the other end completely detinned.

PLATES FOR OCTOBER HIGHEST SINCE JULY

▲ October steel plate shipments of 1,101,382 net tons were the second largest on record, H. G. Batcheller, Chief of the ron and Steel Branch, reported today. Approximately 80 per cent of this tonnage was for direct use by the Army, Navy and Maritime Commission, with the remainder being for export and essential civilian needs.

The tonnage shipped last month was the largest since July, when a record of 1,124,118 net tons was established. Of October shipments, 536,981 net tons were produced on converted strip mills, 449,895 net tons on sheared plate mills and 114,506 net tons on universal plate mills.

PRODUCTION RECORDS SET IN OCTOBER

▲ With a total of 7,584,864 net tons of steel, October production broke all prior record by a considerable margin. This tonnage was 191,953 tons greater than the previous record set last March, and represents an operating record of 100.1 per cent of rated capacity for the industry.

▲ A new world record for blast furnace production was set in October by the "H" stack of Bethlehem Steel Company at Lackawanna, New York. Producing 46,246 tons, the furnace bettered its own previous record of 44,065 tons, made in August.

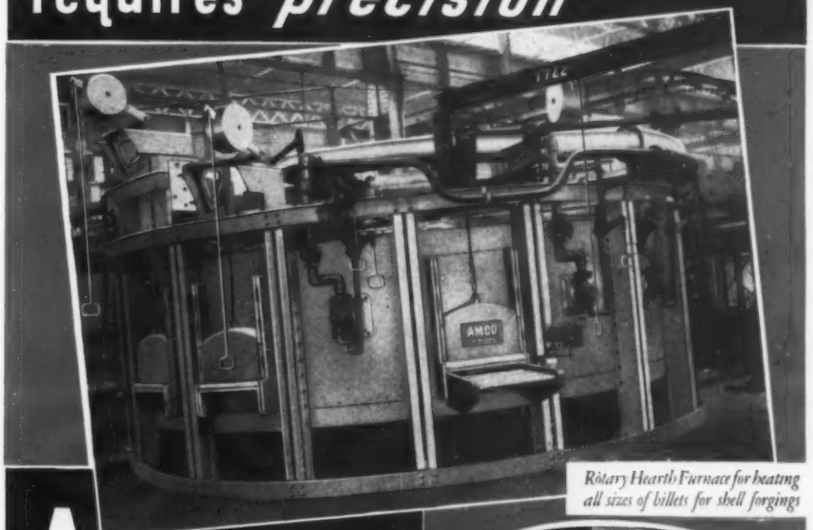
NEW ALLOY SAVES CRITICAL METALS

▲ Eighteen tons of scarce metals will be saved in the manufacture of General Electric war products this year, thanks to a new non-magnetic manganese alloy.

The new alloy will free 10 tons of nickel, seven tons of chromium and almost one ton of tin for other war uses. All three metals are listed by the War Production Board as "inadequate for war and most essential uses" while manganese, the substitution of which makes the saving possible, is available in adequate quantities.

The new alloy replaces a formula which called for 18 per cent chromium, eight per cent nickel and the remainder iron. Either alloy requires a covering to permit soldering, and for the tin coating previously used, a lead coating has been substituted. Adequate supplies of lead are available.

Heating ordnance materials requires *precision*



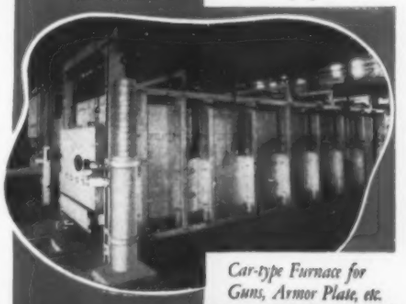
Rotary Hearth Furnace for heating all sizes of billets for shell forgings

AMCO FURNACES

..have successfully met this vital need

The heating of shell and gun forgings calls for *uniform temperatures!* AMCO FURNACES are modern versions of *designs proved in actual service*...the acid test for such important operations. Write for details on the complete line of AMCO Furnaces, one of which will no doubt serve your particular purpose!

Gun Forging Furnace



Car-type Furnace for Guns, Armor Plate, etc.

The AMSLER-MORTON COMPANY
FULTON BUILDING • PITTSBURGH, PA.

According to J. Q. Adams, steel specialist in the company's Schenectady works laboratory, the new formula provides a much stronger alloy.

"This alloy can therefore be expected to remain in general use when the war ends and chromium, nickel and tin again will be in common use," he said.

Bars, rods and plates made of the new alloy are used in motor-generators for submarines, control equipment for planes and tanks, and in switchgear equipment and motors for war industry generally. Wire made of the alloy has equally wide application, chiefly in electric locomotives. In this application the wire is wound tightly around the armatures of direct-current motors and soldered.

BOOKLET DESCRIBES NEW ROLL GRINDER

▲ Operating and engineering executives responsible for the accuracy and finish of ground rolls, cylinders and shafts will find much information of practical value in a comprehensive new booklet just issued by Farrel-Birmingham Company, Inc., Ansonia, Connecticut.

This booklet describes the advanced design, construction and operating advantages of the Farrel Type TT roll grinder with moving work table. This machine was developed to meet today's needs for high output of precision ground rolls with a minimum of skill on the part of the operator. Many important new features automatically assure, or greatly facilitate, accuracy in setup and operation. The machine will grind rolls with either straight, concave or convex contours to predetermined standards of accuracy and finish. A patented attachment for grinding tapers can be incorporated in the machine when it is built or it can be added after the machine is installed. Shafts and other cylindrical work can also be ground.

Farrel Type TT roll grinders are built in three sizes, to take maximum diameters of 24, 28 and 32 in. and in any length required. The new bulletin conveniently tabulates specifications, dimensions and weights for each of the different sizes. Standard equipment and optional attachments are described and electrical equipment requirements given. A number of photographs, diagrams and drawings illustrate the features of the machine.

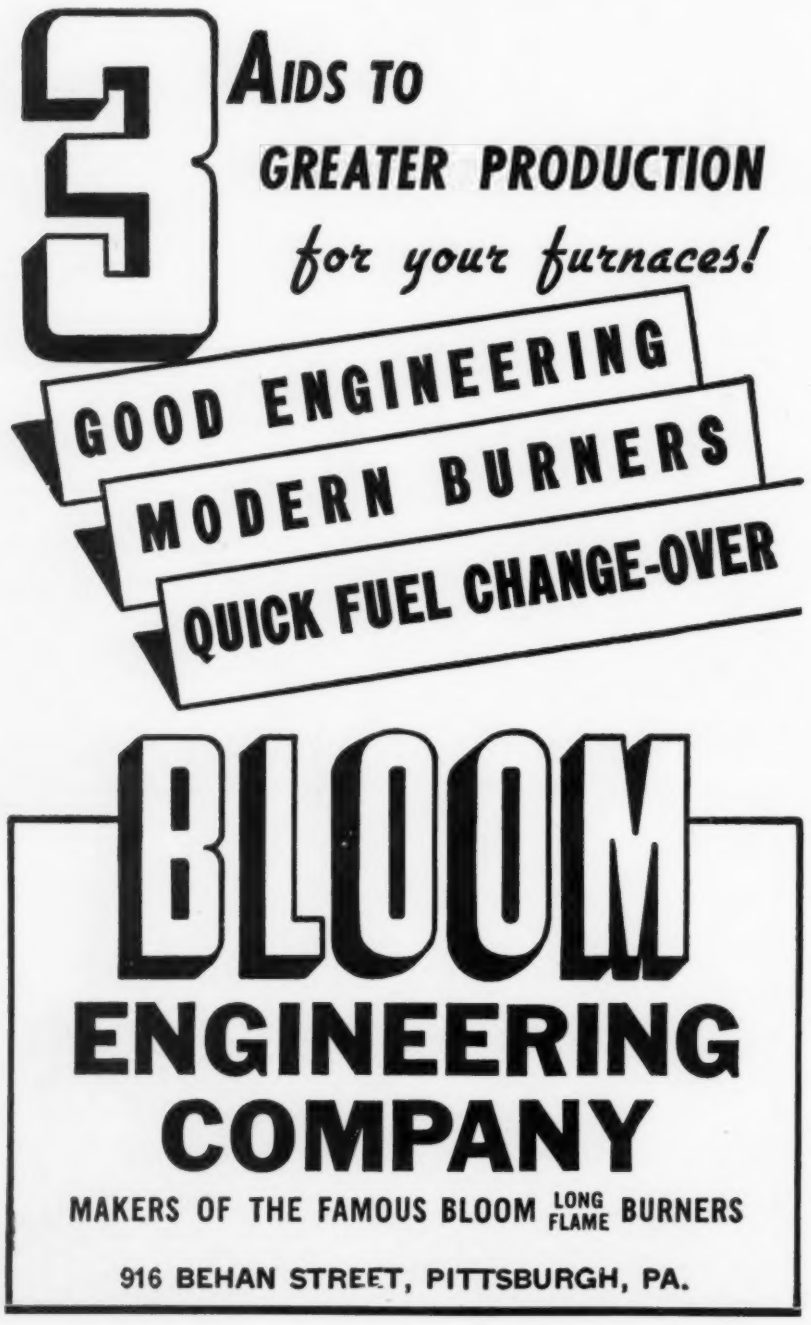
This bulletin is of timely interest and value just now with the expanded demand for machines which aid in the production of uniformly accurate, highly finished rolled sheets and strip. Copies will be sent without charge upon request addressed to Farrel-Birmingham Company, Inc., Ansonia, Connecticut.

INLAND BLOWS IN NEW BLAST FURNACE

▲ The Inland Steel Company, on Monday, November 16th, placed in operation its new No. 6 blast furnace at Indiana Harbor, the first new blast furnace built in the Chicago district since the war began.

The new furnace, built to replace one of the older furnaces, is known as Madeline No. 6, having been named after the late P. D. Block's daughter, who is now Mrs. Henry Straus of Glencoe, Ill. Mr. Block was one of the founders of the company and at the time of his death was chairman of Inland's executive committee.

Mrs. Strauss, after whom all the plant's blast furnaces have been named, pressed the button which started new No. 6 into operation. In attendance at the "blowing in" ceremony, besides company officials, were representatives of the Army, Navy



and War Production Board in this area.

Wilfred Sykes, Inland president, was one of the principal speakers on the program. E. L. Ryerson, chairman of the board of directors, and the following other company officials were present: L. E. Block, L. B. Block, J. H. Walsh, H. H. Straus, A. C. Roeth, P. D. Block, Jr., and W. D. Truesdale.

Major L. J. Brunton and Lt. Edwin Kitch represented the Chicago Ordnance district of the Army; the Navy was represented by Lt. Commander Lester Berry, Lt. W. M. Jennings and Lt. A. R. Pfeltz (jg), of Chicago. Harvey Hill, John Nuveen, W. E. Simons and H. E. Blanchett represented WPB.

F. M. Gillies, general superintendent of the Indiana Harbor plant, was master of ceremonies. The operating force from the blast furnaces at the plant also participated in the ceremony.

According to Mr. Sykes, Inland had anticipated that there would be a shortage of scrap and proceeded with plans for the building of the new blast furnace. Now that it has been placed in operation, he remarked, there will be assurance that maximum production of iron will be maintained.

Another speaker, H. W. Johnson, assistant general superintendent of the plant, praised the work of the men on production in the plant and noted that their reward is in the knowledge that a good job is being done. They will not, he said, have parades in their honor. Only figures on sheets of paper telling the tonnage produced will reflect their all important contribution to the war program.

The company's five other blast furnaces have been operating at maximum capacity since August, 1940, each producing about 1,000 tons of much needed iron to the war program daily. Because of the continuous push for production a toll has been exacted from the furnaces, and two have a doubtful life expectancy. No. 3, in fact, is in need of a complete rebuilding.

Inland had visualized the situation before Pearl Harbor and determined to insure maximum production by building the new furnace and having it ready before No. 3 or any of the others failed. Every effort will be made to keep even the doubtful furnaces in operation as long as possible.

NEW LITERATURE

▲ "Air Clean as a Whistle," new 4-page bulletin describing the application of Precipitron Electric Air Cleaning for large rotating electric machinery, is announced by Westinghouse Electric and Manufacturing Company.

Precipitron reduces shut-downs, maintains operating efficiencies for main drive motors and motor-generator sets, helps prevent excessive temperature rises, fire hazards and electrical breakdowns.

This illustrated bulletin tells what the Precipitron is, how it operates, and how it is installed. When air is cleaned by this method, particles as small as 1/250,000 of an inch in diameter are removed.

A copy of Booklet B-8605 may be secured from Westinghouse Electric and Manufacturing Company, Edgewater Park, Cleveland, Ohio.

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Vaportight
Industrial Lighting
CONDULETS
For boiler rooms, shower rooms, powerhouses, tunnels, docks, building entrances, and all indoor or outdoor locations where exposed to vapors, moisture, rain, smoke, or non-explosive dust and gas.
● Vaportight and Raintight
● Wiring Chamber remains vaportight even though globe is off.
● Screw guard or clamp guard types
● 12 Different hub arrangements
● 4 Reflector Styles
● A variety of accessories—colored globes, guards, half shades, adapters.
● 4 Sizes—50 through 500-Watt
Other Vaportight Lighting Fixtures are available for attachment to many round base Condulets and sheet steel outlet boxes. The complete line includes Vaportight Hand Lamps, Switches, Plug Receptacles, and other electrical devices.
A Nationwide Distribution Through Electrical Wholesalers
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CROUSE-HINDS COMPANY OF CANADA, LTD., Main Office and Plant: TORONTO, ONT.

▲ The Askania Regulator Company of Chicago announces the completion of their new bulletin on the subject of open hearth control. This bulletin contains valuable and interesting data for any one concerned with the modern and efficient operation of the open hearth furnace and delineates in detail the advantages of the jet pipe principle and its basic application to the various phases of control. Copies of this bulletin are available by merely writing Askania Regulator Company, corner 16th and Michigan Avenue, Chicago.

▲ Horizontal drawout metal clad switchgear in 100,000, 150,000 and 250,000 kva capacities at 5,000 and 15,000 volts is described and illustrated in a new 12-page publication, Catalog 1110, just released by Roller-Smith Company, Bethlehem, Pennsylvania.

The advantages of metal-clad switchgear in safety, reliability and ease of installation and maintenance are pointed out. Construction details on the Roller-Smith design are described and illustrated. Complete dimensional data on the various types of gear available, also is included.

Copies of Catalog 1110 can be obtained without charge from Roller-Smith Company, Bethlehem, Pennsylvania.

▲ A new bulletin No. 942 has just been issued by the Carbone Corporation, Boonton, New Jersey, manufacturers of carbon brushes. This bulletin gives in convenient form a number of useful references, including a table of applications, brush definitions, standard shunt connections and detailed specifications of a number of frequently used grades. Copies of this bulletin may be had upon request.

▲ The Hauck Manufacturing Company, Brooklyn, New York, announce the availability of a new sixteen-page catalogue describing the Hauck Proportioning Burner. It is profusely illustrated giving much tabular data together with diagrams for automatic control hook-ups, installation pictures and much other information which should be of interest to users of burners. This company will be very glad to mail a copy to anyone requesting it.

▲ The Brown Instrument Company, Philadelphia, has recently published a 64-page booklet titled, "The Technique of Precision Control in Industrial Processes." This booklet has been prepared to acquaint engineers, operators and management with the manifold applications of Automatic Control to industrial processes.

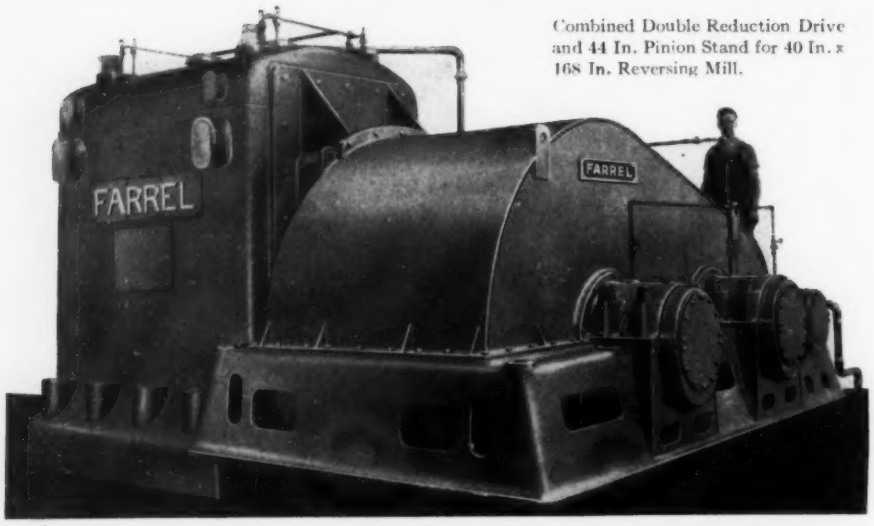
The test is divided into chapters which feature precision measurement, fundamentals of control, types of controls, control valves and typical applications.

The many illustrations throughout this booklet are examples taken from current practice in varied industries and include schematic diagrams of basic control systems and illustrations of control apparatus.

The "Technique of Precision Control in Industrial Processes" is offered in the hope that it will provide the reader with a clearer concept of the fundamentals involved in industrial process control and assist him in the proper selection of automatic equipment.

A copy of this booklet will be sent to any of our readers upon request. Write to the Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania, and ask for Booklet 80-1.

PRECISION and STRENGTH mark Farrel Rolling Mill Drives for Heavy Duty Service



Combined Double Reduction Drive and 44 In. Pinion Stand for 40 In. x 168 In. Reversing Mill.

The combined double reduction gear unit and pinion stand illustrated is typical of the advanced engineering applied to Farrel heavy duty rolling mill drives.

Ruggedly constructed for strength to withstand stresses, shocks and wear incident to high speeds and heavy loads, these Farrel mill drive units are also made with a high degree of accuracy to provide the quietness and smoothness of operation which is as essential in large mill drives as in smaller machines.

The design provides for rigid connection of both units to assure permanence of alignment. Accurately generated Farrel-Sykes continuous tooth herringbone gears — *"The Gear With a Backbone"* — tapered roller bearings throughout, and an effective lubricating system are but some of the features which assure efficient, economical and dependable performance, long life and trouble-free service.

Farrel rolling mill drives are designed not only to meet the requirements of heavy duty service encountered in modern rolling mill practice, but also to fit the particular conditions in every individual drive installation.

FARREL DRIVES *for* VICTORY

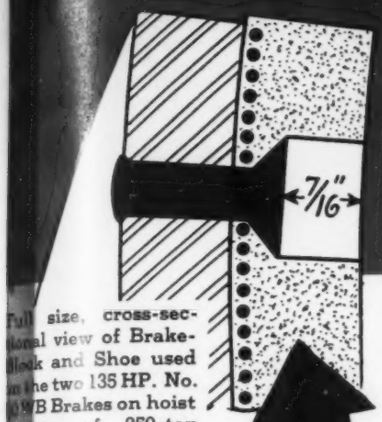
FARREL SYKES GEARS

FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN. - - - - - BUFFALO, N. Y.
The Gear with a Backbone

ON GUARD

Against Slippage

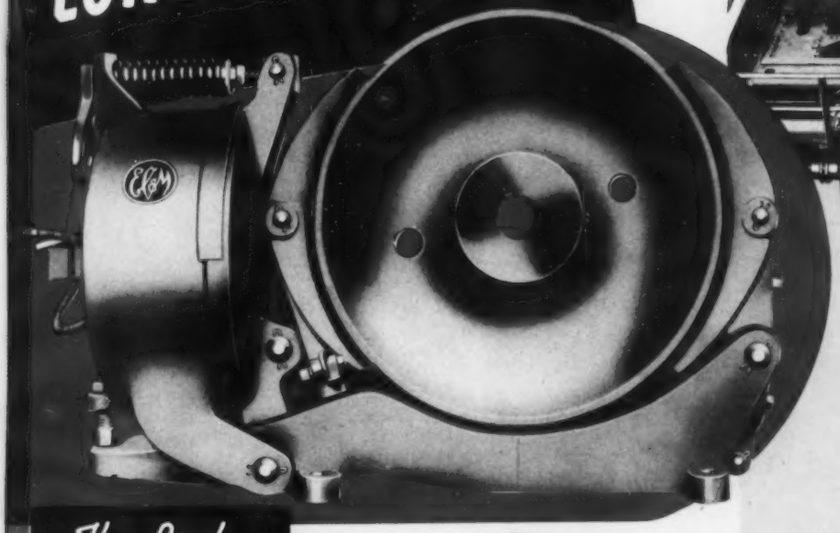
ON CRANES, HOISTS, AND MILL MACHINERY

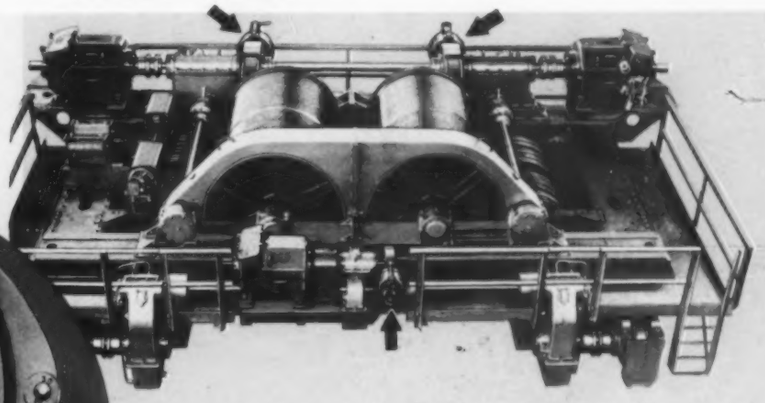


Full size, cross-sectional view of Brake-Block and Shoe used on the two 135 HP. No. 10 WB Brakes on hoist motion of 250-ton Saddle Crane Trolley shown to the right.

EC&M "WB" BRAKES

They Give 2 to 6 times LONGER SERVICE





HERE are the facts why there are thousands of satisfied WB Brake users.

FACT No. 1—Modern brakes are *blocked* instead of lined. "WB" Brakes use blocks from $\frac{1}{16}$" to $\frac{3}{4}$" thick, permitting $\frac{1}{8}$" wear per shoe on the smallest size to $\frac{7}{16}$" on the largest size.

Significance—Automotive vehicles (cars, trucks, busses), for years, have been using blocks, accurately formed to fit the drum to give long-lived braking requiring infrequent adjustment with minimum upkeep.

FACT No. 2—In "WB" Brakes, the ratio of wear on brake-block and wheel to magnetic-air-gap-growth is unusually small.

Significance—For a given wear on block and wheel, the increase in air-gap between magnet and armature is small which means *infrequent adjustment* to compensate for wear.

FACT No. 3—When the "WB" Brake operates, the impact is equalized since both shoes strike simultaneously.

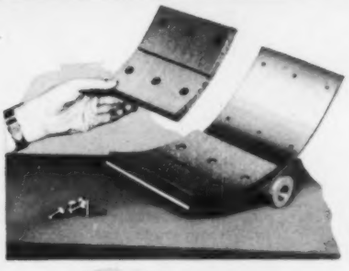
Significance—This eliminates shock on brake frame and bushings, and on motor bearings.

FACT No. 4—The trend is toward EC&M "WB" Brakes.

Significance—Plant managements recognize the improved performance and low maintenance cost of "WB" Brakes and specify this better brake whenever cranes, mill machinery, etc., are purchased.

Other outstanding advantages of EC&M "WB" Brakes are: Low contact-pressure per square inch and 50 per cent of the wheel covered by brake shoes, 50 per cent exposed to give heat radiation. Ask for Bulletin 1004-D describing these efficient, economical brakes for cranes and machinery. Write for your copy of this bulletin to-day.

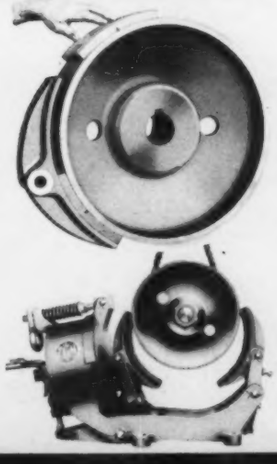
The Brake that's BLOCKED *not Lined*



Blocks, exclusive with "WB's" are moulded, non-compressible, thick and tough. Constant frictional qualities throughout thickness permit complete wear—down to rivet heads. Accurate grinding on both sides to uniform thickness gives precision fit on shoe and on wheel—no "break-in" period when new—easy replacements, if and when needed.

ARMATURES OR BRAKE SHOES QUICKLY CHANGED

There is no brake like the "WB." Motor armatures come out easily—no rods or levers on top to interfere — one operation (compress torque-spring with hand-release)—shoes fold back as armature is lifted out. Insert new armature—back off hand-release and you're ready to go. Simple, mighty convenient, too!



THE *Most Efficient* BRAKE FOR CRANES, HOISTS, MILL MACHINERY

The Well Known

THE ELECTRIC CONTROLLER & MFG. CO. E&M CLEVELAND, OHIO

WB BRAKE

NOW *Available* WITH RECTIFIER UNIT FOR A-C APPLICATIONS . . .

Compact rectifier-unit with brake contactor and resistor. Allows high current for fast release, reduced holding gives current fast brake setting. When used with magnetic control, this equipment is usually combined with the motor control panel.

THE "WB" Brake with Rectifier-unit is a perfect solution to a difficult problem.

ADVANTAGES

No laminated magnets or plungers

No destructive hammer-blow

No A-c chatter

No coil burn-out due to shoe-wear affecting air-gap

No motors, gears or pumps

Has fast release and set

Has ability to permit accurate inching

Has hand release

Has solid cast-steel magnet and armature

Has short armature-movement

Has thick, moulded brake blocks

Has all the advantages of the well known "WB" Brake—the leading brake for D-c applications since 1926.

This is a proven system of braking. Nearly 200 of these brakes and rectifier-units are already in service in the short time they have been available. Several score are on shipyard cranes, others giving highly successful performance on many cranes in machine shops, power plants, metal mills, etc.

New Bulletin 1006 gives complete facts. Write for your copy to-day.

MOUNTED OFF CENTER—YET OPERATES PERFECTLY

Slight inaccuracies in brake mounting often occur and the design of the EC&M "WB" Brake permits a quick, successful solution under these conditions. For example, the illustration at the right shows a "WB" Brake mounted off center—$\frac{5}{16}$" horizontally and $\frac{1}{4}$" vertically—yet, the "WB" Brake operates perfectly.

INVESTIGATE BEFORE BUYING A-c BRAKES

PUT YOUR A-c BRAKE PROBLEMS UP TO EC&M

When buying new A-c cranes and machinery or when revamping old installations, consult EC&M on your brake requirements. Complete information regarding brake-size, dimensions, torque-rating, etc., will gladly be furnished, without obligation, of course.

THE ELECTRIC CONTROLLER & MFG. CO. · CLEVELAND, OHIO

For greater

Victory production

from

your Billet

and Bar Mills

"Techni" Process rolls are made of enriched alloy iron, particularly controlled to produce rolls with the best combination of strength, wearing qualities, non slippage and anti-fire cracking. "Techni" Process, an exclusive Mackintosh-Hemphill development, regulates the quality and grain size of the rolls with as much exactness as the best modern steel practice regulates the quality of steel. Make sure you get the best . . . specify "Techni" Process Rolls.

Since 1803—Pioneers, Engineers and Builders

MACKINTOSH-HEMPHILL COMPANY . . . Pittsburgh and Midland, Pa.

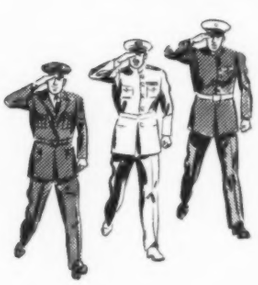
The Rolls with the Red Wabblers — *They Roll More Tons Per Roll-Dressing*

Other Mackintosh-Hemphill Products:

- Rolling Machinery
- Shape Straighteners
- Strip Coilers
- Shears, Levellers
- Pinions
- Special Equipment
- Iron-Steel Castings
- The NEW Abramsen Straightener
- Improved Johnston Patented Corrugated
- Cinder Pots and Supports
- Heavy Duty Engine Lathes

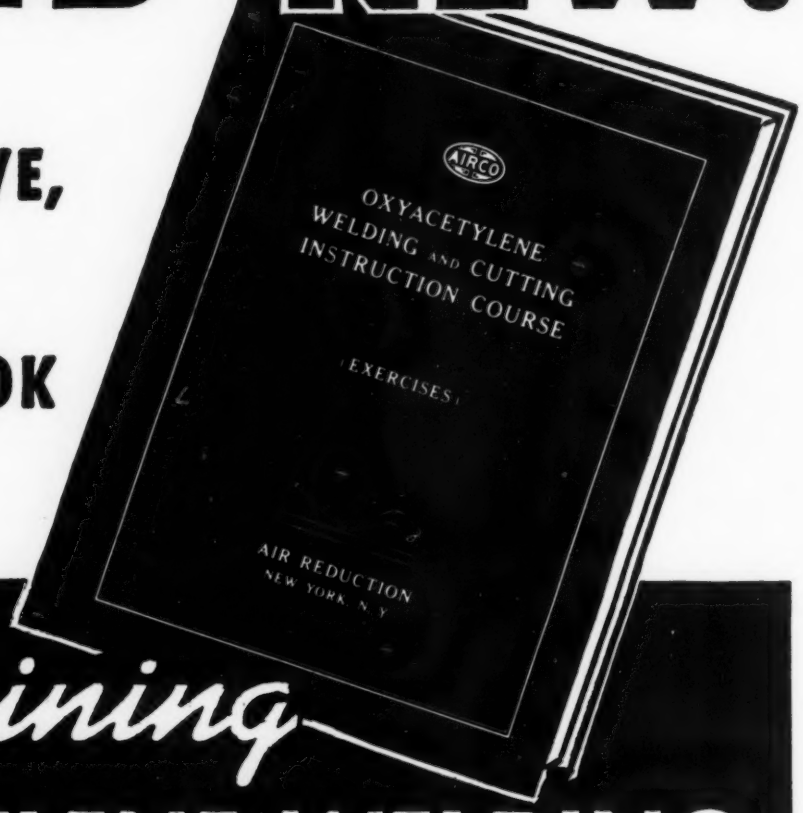
"Techni" PROCESS ALLOY IRON ROLLS

for intermediate
and finishing stands



BRAND NEW!

A COMPREHENSIVE, UP-TO-DATE INSTRUCTION BOOK



For Training OXYACETYLENE WELDING and CUTTING OPERATORS

This book starts at rock bottom—instructs the beginner on set-up of apparatus. It describes welding fundamentals—methods, torch and rod positions and manipulation... procedure for welding, braze welding and low temperature brazing. Lessons cover steel, pipe, sheet metal, cast iron, brass, copper and aluminum.

Without question, this Airco Oxyacetlyene Welding and Cutting Instruction Book will prove an invaluable aid to quickly train oxyacetylene torch operators to meet today's needs. $1.00 per copy, quantity prices on request.

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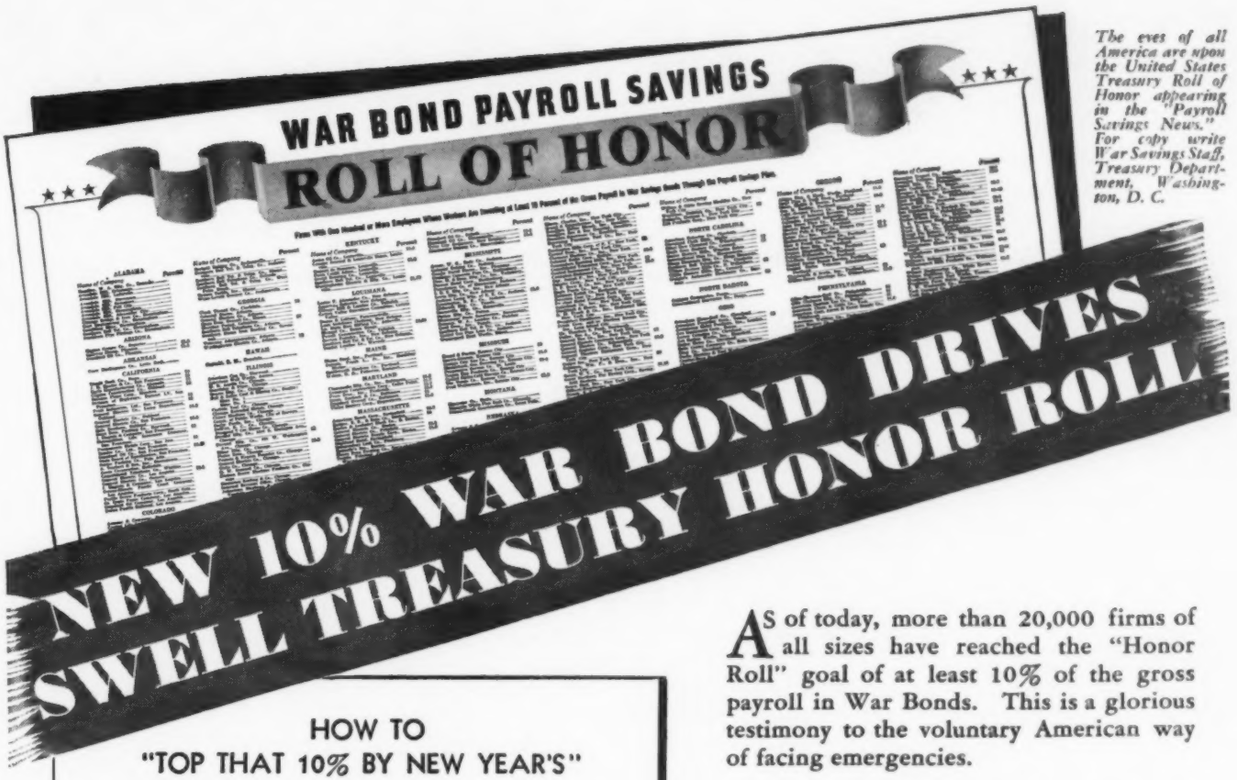
OXYGEN IS PRODUCTION — *Don't Waste it!*



The eyes of all America are upon the United States Treasury Roll of Honor appearing in the "Payroll Savings News." For copy write War Savings Staff, Treasury Department, Washington, D. C.

HOW TO "TOP THAT 10% BY NEW YEAR'S"

Out of the 13 labor-management conferences sponsored by the National Committee for Payroll Savings and conducted by the Treasury Department throughout the Nation has come this formula for reaching the 10% of gross payroll War Bond objective:

1. ***Decide to get 10%.***
   It has been the Treasury experience wherever management and labor have gotten together and decided the job could be done, the job was done.
2. ***Get a committee of labor and management to work out details for solicitation.***
   a. They, in turn, will appoint captain-leaders or chairmen who will be responsible for actual solicitation of no more than 10 workers.
   b. A card should be prepared for each and every worker with his name on it.
   c. An estimate should be made of the possible amount each worker can set aside so that an "over-all" of 10% is achieved. Some may not be able to set aside 10%, others can save more.
3. ***Set aside a date to start the drive.***
4. ***There should be little or no time between the announcement of the drive and the drive itself.***
   The drive should last not over 1 week.
5. The opening of the drive may be through a talk, a rally, or just a plain announcement in each department.
6. Schedule competition between departments; show progress charts daily.
7. Set as a goal the Treasury flag with a "T."

AS of today, more than 20,000 firms of all sizes have reached the "Honor Roll" goal of at least 10% of the gross payroll in War Bonds. This is a glorious testimony to the voluntary American way of facing emergencies.

But there is still more to be done. By January 1st, 1943, the Treasury hopes to raise participation from the present total of around 20,000,000 employees investing an average of 8% of earnings to over 30,000,000 investing an average of at least 10% of earnings in War Bonds.

You are urged to set your own sights accordingly and to do all in your power to start the new year on the Roll of Honor, t give War Bonds for bonuses, and to purchase up to the limit, both personally and as a company, of Series F and G Bonds. (Remember that the new limitation of purchases of F and G Bonds in any one calendar year has been increased from $50,000 to $100,000.)

TIME IS SHORT. Our country is counting on you to—

"TOP THAT 10% BY NEW YEAR'S"

EVERYBODY EVERY PAYDAY AT LEAST 10%

Save with
War Savings Bonds

ITEMS OF INTEREST

Edward S. Coe, Jr., has been appointed as manager of the New York office of Farrel-Birmingham Company succeeding Mr. E. H. Thomas, recently deceased.

To his new post Mr. Coe brings a varied experience and knowledge of the company's products gained in a number of positions he has held in the company since 1936.

Following two years at the Buffalo plant on gear sales he spent a brief period at the New York office and then over a year as sales engineer in the Chicago office. The next three years were spent at sales engineering at the company's main office in Ansonia. For the past few months he has been in charge of expediting production of Farrel-Sykes gear generating machines.

Born in Worcester, Massachusetts, Mr. Coe received his early education there and graduated from Worcester Polytechnic Institute in 1931 with a degree of Civil Engineer. Following his graduation he worked at the Trenton and Worcester plants of American Steel and Wire Company for four years before joining Farrel-Birmingham Company.

Lauson Stone has resigned as assistant to the president of Jones and Laughlin Steel Corporation, to become president of Follansbee Steel Corporation, John

LAUSON STONE

Follansbee, chairman, announced recently. Mr. Stone was associated with Jones and Laughlin for 23 years, and in his new position succeeds W. T. Brownscombe, who has resigned because of ill health.

Edwin H. Brown, engineering vice-president of the Allis-Chalmers Manufacturing Company, has been named as assistant chief of the iron and steel branch in charge of the plant facilities section of the War Production Board.

Brown succeeds Don. N. Watkins, who resigned to return to his post as president of Steel Publications, Inc. According to Hiland G. Batcheller, chief of the iron and steel branch, Brown's work will be valuable in the "all-important task of guiding the construction and utilization of steel plant facilities."

To enable Brown to assume his new wartime assignment, he has been granted an indefinite leave of absence. During his absence, Forrest Nagler, chief mechanical engineer, will be in charge of the Allis-Chalmers engineering and development department.

Charles M. Beeghly, formerly associated with the Cold Metal Products Company, Warren, Ohio, has joined the Army Air Force. He is stationed in Florida.

Alexander C. Brown of Cleveland, Ohio, has been appointed as deputy chief of the Iron and Steel Branch of the War Production Board.

Mr. Brown has been first vice-president of the Cleveland Cliffs Iron Company since 1934. He was educated at Yale University and at the Case School of Applied Science. During the first World War, he served as chief of the crane section of the War Industries Board.

Julius A. Clauss, chief engineer, Great Lakes Steel Corporation, has been appointed assistant on production problems to Hiland G. Batcheller, Chief of the Iron and Steel Branch, War Production Board.

Mr. Clauss started his steel mill career with the Lackawanna Steel Company, which company he was with for seven years. He then went with Corrigan-

JULIUS A. CLAUSS

McKinney Steel Company for two and one-half years as chief designer and checker. Following this he was the chief draftsman for the William Tod Company at Youngstown, Ohio. Leaving this company he went with the Republic Iron and Steel Company as assistant chief draftsman for twelve years. The next three and one-half years he served as chief engineer for the Trumbull Steel Company, and from March 1929 he has been with the Great Lakes Steel Corporation, at Ecorse, Michigan, as chief engineer.

A. L. Milton, staff engineer for the Wheeling Steel Corporation, died October 3rd from injuries received in an automobile accident. Mr. Milton was born in Wheeling, West Virginia, where he attended the public schools,

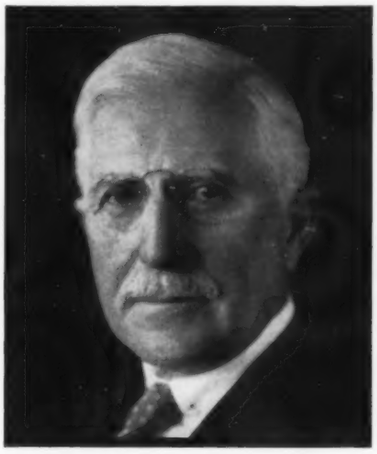
subsequently graduating from Lawrenceville Preparatory School and Cornell University. He later completed a post graduate course at Linsly Institute of Technology. He became associated with Wheeling Steel in 1916 as steam and fuel engineer at the Benwood plant. Aftes a period of war service in France as an army officer, he returned to his former duties, being promoted to assistant general engineer in 1925.

In February, 1934, Mr. Milton was transferred to the Yorkville plant as plant engineer, and in 1941 was made mechanical superintendent. In March 1942, he was transferred to the general office.

Mr. Milton was a member of the Association of Iron and Steel Engineers since 1921.

George Matthew Verity, founder of the American Rolling Mill Company, died Friday, Novembes 6, at his home in Middletown, Ohio. He was 77 years of age.

Mr. Verity was internationally known and an outstanding figure in the American steel industry. He founded the American Rolling Mill Company 50 years



GEORGE MATTHEW VERITY

ago and at the time of his death was chairman of the board of that company, having been succeeded as president by his son-in-law, Charles R. Hook in 1930.

George M. Verity was born at East Liberty, Ohio, April 22, 1865, the son of an itinerant preacher. In 1886 he became manager of the W. C. Standish Wholesale Grocery Company of Cincinnati. Three years later he became general manager of the Sagendorf Iron Roofing and Corrugating Company in Cincinnati, which in 1891 was re-organized as the American Steel Roofing Company of which he was made vice-president and manager. This led to his founding of the American Rolling Mill Company in Middletown in 1899.

George M. Verity was more than an outstanding figure in our industry. He was an exemplification of the sterling characteristics that have provided the leadership to make American industry at its best.

New Style PUMPS
for the New Ships
On many of the ships recently built and now under construction, the methods of handling fuel and lubricating oil have been vastly improved by adoption of the
De Laval-IMO Oil Pump
Its exceptional compactness and its ability to operate directly connected at motor and turbine speeds save space and weight, and greatly simplify the power plant layout. There are only three moving parts; no valves, no gears, no separate bearings, no reciprocating parts. The pump interior is readily accessible.
Ask for Catalog 1-96.
To handle 175 g.p.m. of 200 to 500 SSU lube oil against 50 lb. gage from 15 in. Hg. suction at 1750 r.p.m.
IMO
IMO PUMP DIVISION
of the De Laval Steam Turbine Company
Trenton, New Jersey

LOOKING for MORE TOUGH JOBS
On the widest range of TOUGH Rolling Mill Service, GATKE Fabric Bearings are eliminating delays and avoiding costly machine shop service. Precision moulded in all shapes and sizes for installation without machining. Made of many different material combinations to meet various service requirements in types for water lubrication, oil- or grease-lubrication and some unlubricated applications. Write for particulars.
Gatke MOULDED FABRIC Bearings
GATKE CORPORATION - 228 N. La Salle - CHICAGO

INDUSTRIAL EXECUTIVES!

THE SCRAP FROM YOUR PLANTS IS NEEDED AT ONCE TO KEEP WAR PRODUCTION MOVING!

YOU know that all our furnaces and mills must be kept working at top speed to win this war. Yet the steel industry, already producing record quantities, cannot attain its full, needed war-time capacity of 90,000,000 tons unless 6,000,000 additional tons of scrap steel is uncovered promptly.

This critical situation can be solved only by the patriotic cooperation of every American manufacturer.

In your plant, lying around in repair shops and storerooms, is the scrap America needs to give our boys the fighting tools they must have to win . . .

Broken castings, pipe, obsolete machinery, abandoned line shafting, pulleys, pumps, old boilers, storage tanks, beams, rails, fencing, track, chains, cable, rusty bolts, nuts, and rivets . . .

Round them up and get them moving to the front!

. . . Like the gas appliance manufacturer who searched his plant and found 90 tons of scrap metals . . . or the paper mill that "mined" 1,800 tons of steel from its plants . . . or the rubber company that asked its foremen to "stop holding things" and collected 1,608 tons of iron and steel from old molds and obsolete machinery in a single week!

What others have done, you can duplicate. Walk through your plant with "Scrap" in your mind—you'll be amazed at the harvest. But get it into the fight, *at once* . . . the war won't wait!

★ ★ ★

HERE'S WHAT TO DO... Appoint one man as Salvage Manager for your organization. Give him authority to *act*—to condemn old equipment, to move material, to collect scrap of all kinds. Have him separate all scrap by type. Then move it promptly through your regular scrap dealers. Don't wait — start rounding up scrap *now* — and keep your scrap moving until the war is won!

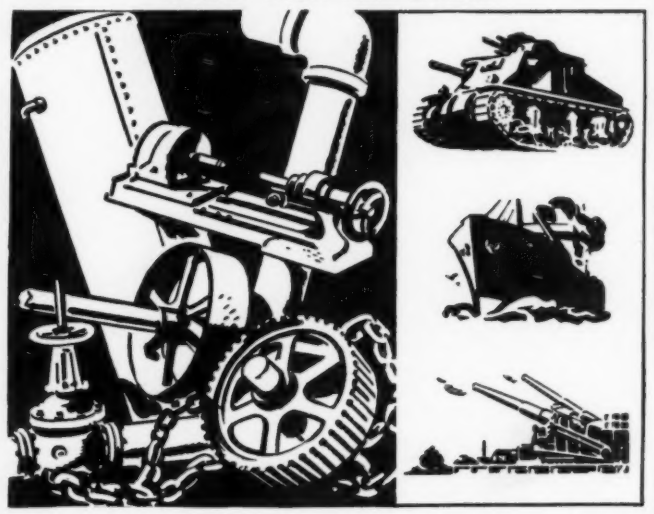
THROW YOUR SCRAP INTO THE FIGHT!

DONALD M. NELSON
says to all industry:

"The shortage of scrap materials for war production is acute. 6,000,000 extra tons of scrap iron and steel alone are needed this year, and vast quantities of rubber, copper, brass, tin, lead and zinc. Without your immediate, active cooperation — whether you have war work or not—we cannot lick this problem. We urge you to organize at once an all-out collection drive in your plants for these materials."

SCRAP NEEDED FOR WAR

SCRAP IRON AND STEEL



50% of every tank, ship, and gun is made of scrap iron and steel!

Other metals—Rubber—Rags—Manila rope—Burlap bags

Thousands of tons of these materials are needed to make bombs, tires for jeeps, surgical supplies for military hospitals, wiping rags for guns, insulation for electric wiring, parachute flares and sandbags.

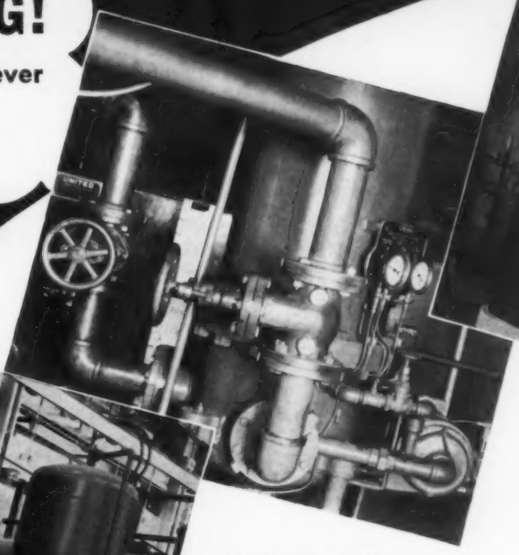
This message approved by Conservation Division

WAR PRODUCTION BOARD

This advertisement paid for by the American Industries Salvage Committee (representing and with funds provided by groups of leading industrial concerns).

KEEP 'EM FLOWING!

A Cuno Filter in the line means you never have to shut down for fluid-cleaning.



80" hot strip mill

Cuno Auto-Klean Filter protects gear reduction system, pinion stands, oil bearings and motor bearings . . . is cleanable without stopping fluid flow.

Cold strip mill

Cuno Flo-Klean Filter strains roll body coolant. Backwash of filtered fluid dislodges accumulated solids. Nothing to replace or clean.

54" hot strip mill

Cuno Flo-Kleans protect nozzles of hydraulic descaling sprays from abrasive particles, provide continuous recirculation.

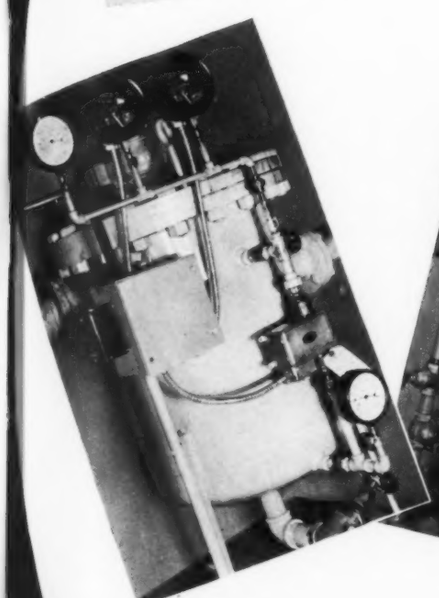
Open hearth furnace

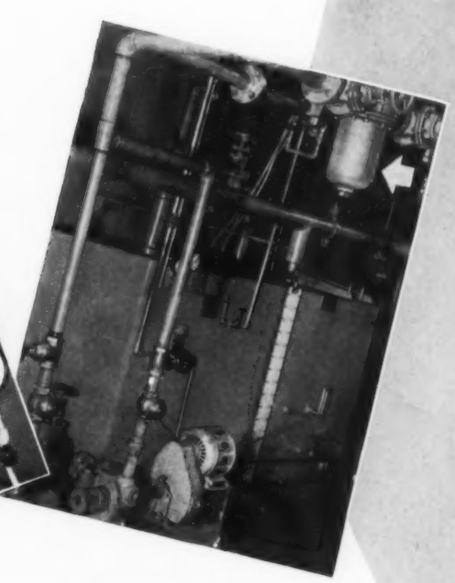
Cuno Auto-Klean Filters keep solids in fuel tar from clogging up burner nozzles, meters and feed lines. Fluid keeps on "GO".

NON-STOP PRODUCTION AND CONTINUOUS PEAK PROTECTION

Cuno Auto-Klean (disc-type); for lube, fuel and quenching systems. Positive removal of all solids larger than specified spacing between all-metal discs. Handles full flow.

Cuno Flo-Klean (wire-wound); for descaling spray, coolant and hydraulic systems. Self-cleaning, abrasion-resistant. For individual or centralized systems.





Cold strip mill

Cuno Auto-Klean handles 50 g.p.m. of oil, 2300 SSU at 100°F, for pinions. No stops for cleaning fluid, no stops for cleaning filter.

Oil type roll neck bearings

Compact Cuno Auto-Klean handles 30 g.p.m., is cleaned merely by turning a handle. All-metal filter element never needs replacement.

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

CUNO ENGINEERING CORPORATION
911 South Vine St., Meriden, Conn.

Send me free booklet, "Quick Facts."

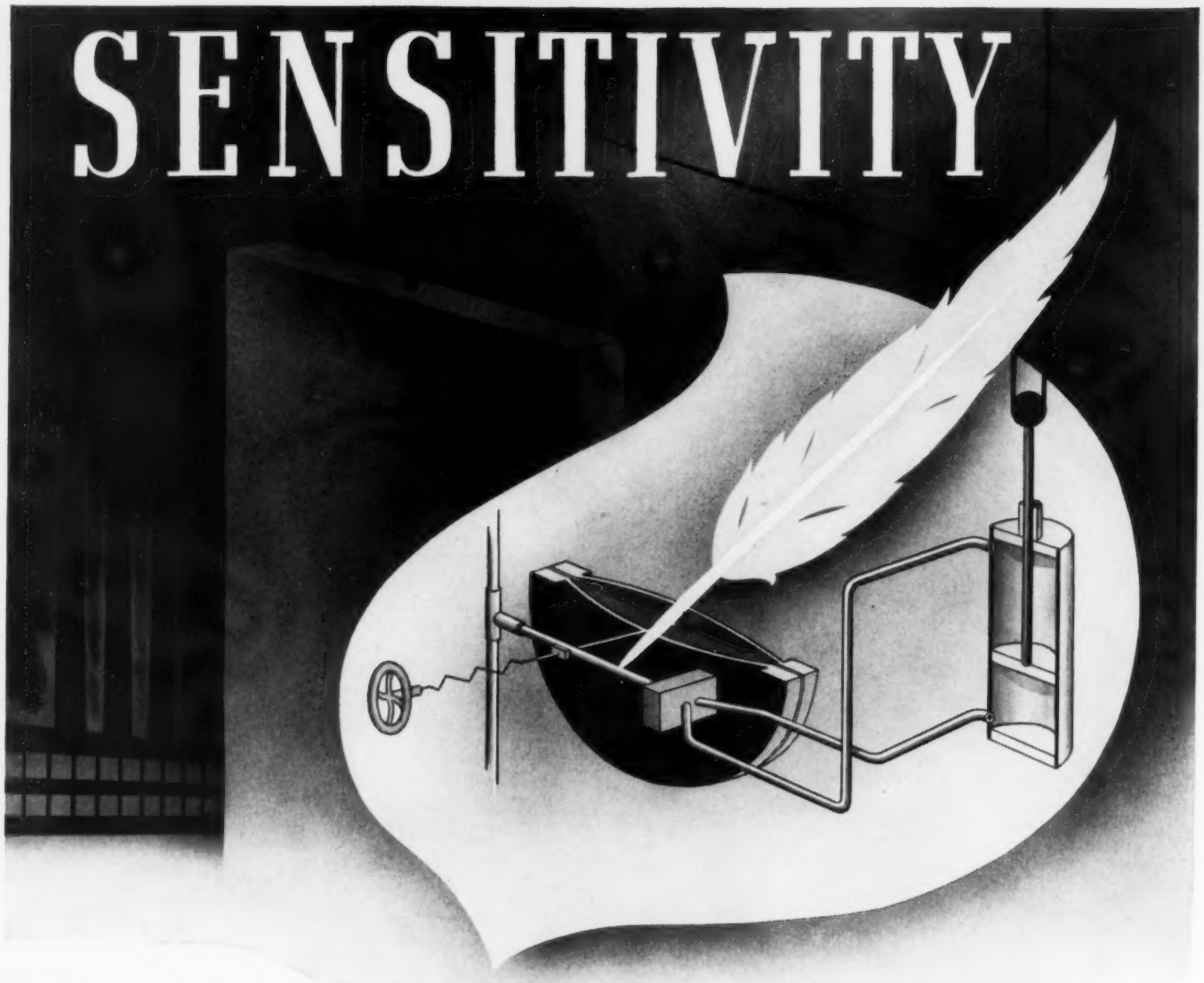
Name .....

Company .....

Address .....

Product to be filtered .....

SENSITIVITY



*1/10 of a Featherweight operates a

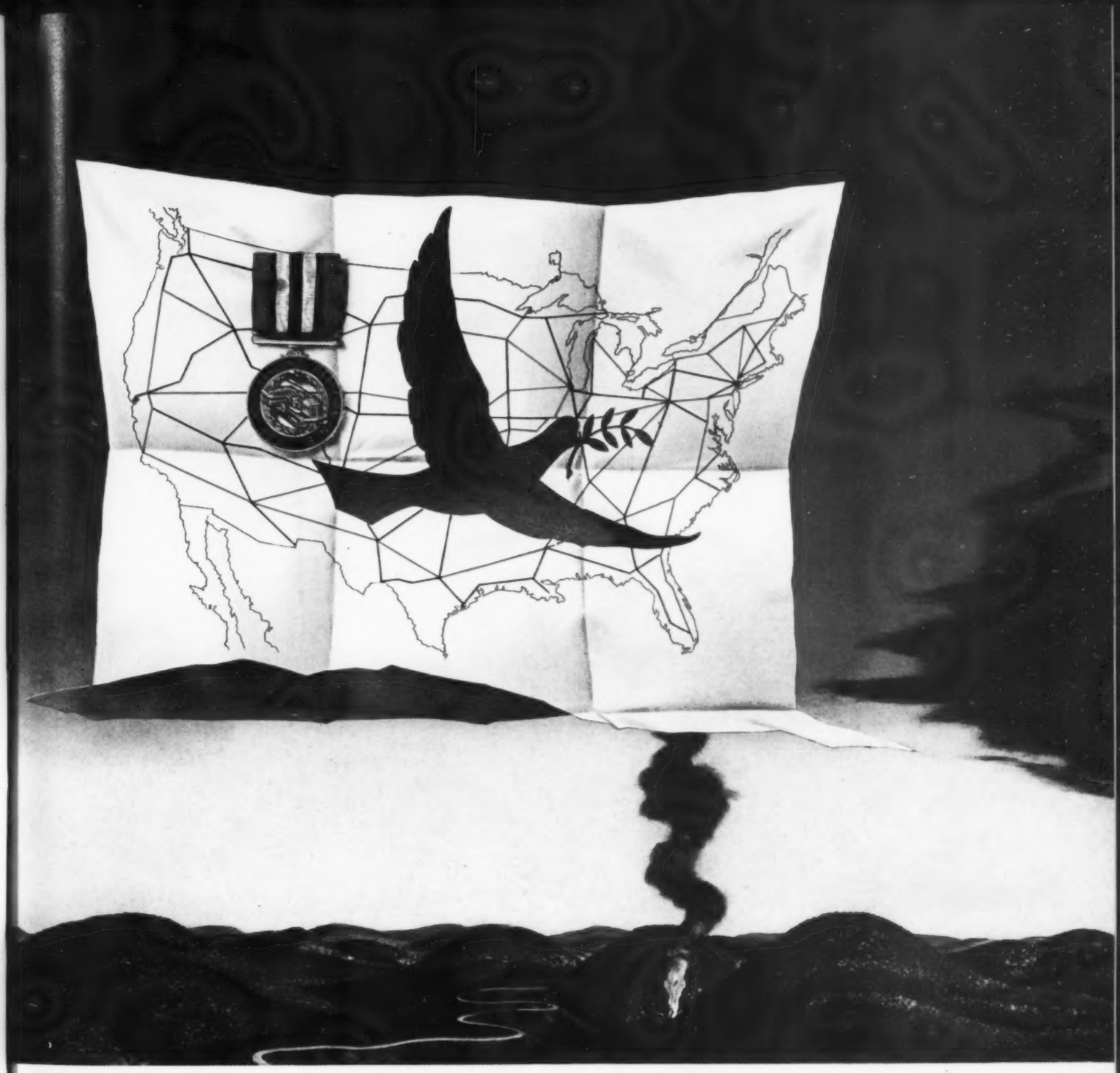
4000 POUND DAMPER

Today Askania is serving our vital industries in a multitude of ways... saving valuable man hours in the complex process of making steel and contributing to increased tonnage of better steel at lower cost ... in the field of prime movers Askania's basic simplicity and sensitivity plus its rugged durability are proving themselves in the savings ... protection and increased production effected. An Askania bulletin pertinent to your problems awaits your inquiry ... address Askania Regulator Co., 1607 S. Michigan Avenue, Chicago

JET PIPE PRINCIPLE

*Specifically .001" W. C.

ASKANIA
REGULATOR CO. CHICAGO
AUTOMATIC CONTROL



America built her Burma Roads in Peace

The spectacle of a friendly nation of half a billion people dangling from one thin, precarious, mountain-clinging supply line made the Burma Road probably the most famous military road of all time.

America, with but a quarter of the population of China, built the finest highway system in the world. That highway system today is paying the nation an unexpected "dividend." For the development of the American highways contributed to the growth of the American coal tar industry and the coal tar industry is now one of the important sources of highly-essential war materials for the nation.

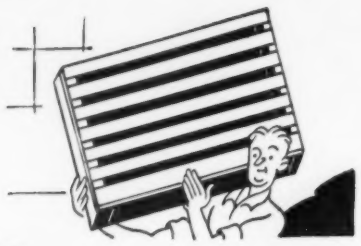
Large quantities of coal tar that formerly went into roads are now being used to make pitch coke and carbon pitches that are important in aluminum manufacture . . . core pitches that help speed the casting of airplane and tank parts . . . naphthalene, from which is made one of the ingredients of flashless powder and of new-type paints for battleships . . . creosote to pressure-treat timber for piers and docks and for construction work, where it is releasing much-needed steel . . . tar acids for plastics . . . target pitch which is helping American marksmen learn to follow the flight of an enemy plane . . . and many other products.

Koppers is producing millions of gallons of coal tar for these purposes and processing it for the recovery of these vital war materials. In addition, it is still turning out huge quantities of road tar for the construction of access roads and airport runways and for the maintenance of existing highway surfaces.—Koppers Company, Pittsburgh, Pa.

Buy United States War Bonds
and Stamps

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY



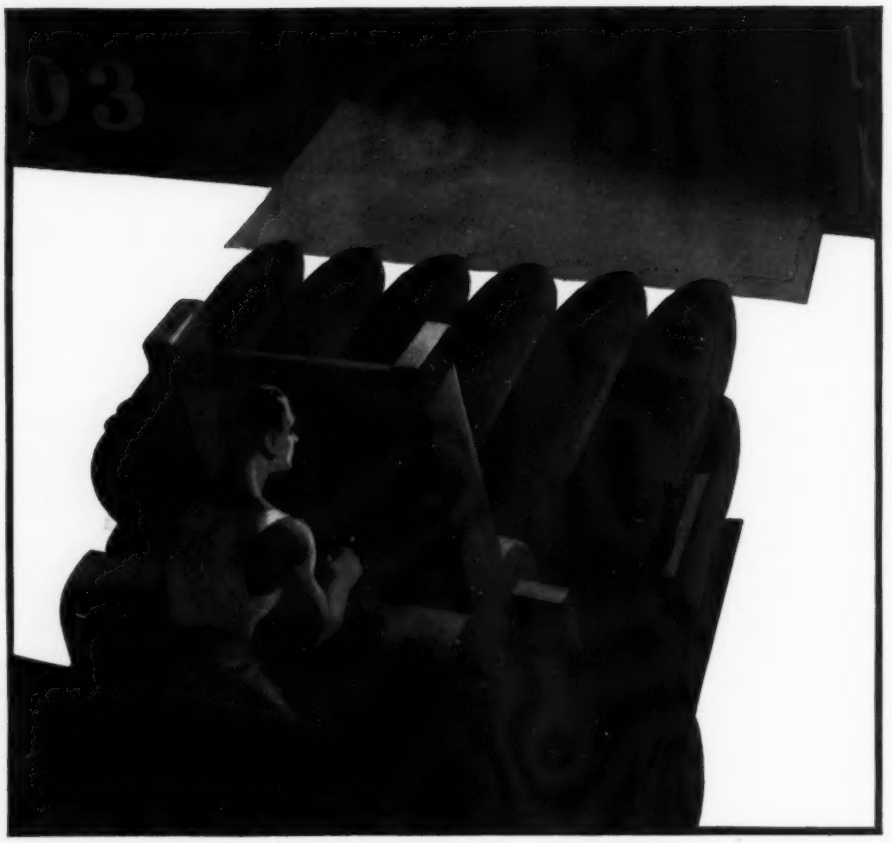
Simple Battens Conserve Precious Cars. War materials boxed or crated for shipment in units of one to three tons can be loaded by battery industrial trucks into outgoing cars in a small fraction of the time formerly required. An aircraft engine manufacturer loads cars in as little as 20 minutes by this method. All that is needed is a pair of simple 2 x 2 battens underneath to provide the necessary fork clearance. *And, when the consignee unloads cars by the same method, the saving is doubled.*

New Ideas in Material-Handling. New and better ideas for keeping war production flowing are constantly being developed by material-handling supervisors. One clearing house for such ideas—and an authoritative one—is Storage Battery Power, our house magazine. Articles describing the latest sound methods appear regularly. Write us for a copy if you are not already on our mailing list.

Foresight. Foresight is paying its dividends now in plants whose material-handling trucks are equipped with alkaline batteries. Men who specified them can take justified personal pride in their judgment. Alkaline battery care is restricted almost solely to simple maintenance and charging; repairs are seldom necessary; failure in operation rare indeed. They are like the good workman who shows up for his job every day on time—and does his work flawlessly the whole shift.

Edison Storage Battery Division
Thomas A. Edison, Inc.
WEST ORANGE, N. J.

POWER
delivered as ordered



American industry is mechanized, too. Industrial trucks powered by Edison Alkaline Batteries are carrying war production . . . to waiting machines for processing . . . to trucks and trains and boats. Their unfailing power is eliminating waiting time and congestion, expediting rush war materials . . . increasing production in every foot of space available.

Over half of the battery industrial trucks of America are powered by Edison Alkaline Batteries. This is because alkaline batteries are so predictable in performance . . . because they are so rugged structurally and electrically . . . because they are so easy to maintain. Because they deliver power where and when ordered—

INDUSTRY NEEDS THE DEPENDABILITY OF

Edison Alkaline BATTERIES

Use Your Oxy-Acetylene Cutting Blowpipes *to* HELP GET IN THE SCRAP!

To help bring in the large amounts of steel and iron scrap so essential to continued high levels of steel production, your oxy-acetylene cutting blowpipes can be used to good advantage. This is true because large tonnages of potential scrap are to be found in obsolete machines, structural shapes, pipe, old boilers, and other pieces too bulky or heavy to be moved conveniently. With oxy-acetylene cutting blowpipes, such material can quickly be cut up for easy handling and disposal. In addition, scrap that is cut to charging box size usually brings higher prices that will more than repay the cost of cutting up. Outlined here are some suggestions that may help you in making available the largest amount of scrap in the least time and with highest returns for your effort.

1. Explore Your Plant and Property, and appoint someone to ear-mark every piece of machinery and equipment that can be spared for scrap.
2. Contact Your Local Scrap Dealer or Salvage Committee and find out to what lengths the scrap should be cut for highest returns.
3. Classify and Segregate alloy steels and other special materials—including copper—whenever it is desirable. Make provisions for doing this during scrapping operations.*
4. Centralize Your Scrapping Operations as much as possible. This will speed up the work, will minimize lost motion and rehandling, and also will tie up less equipment and fewer oxygen and acetylene cylinders.
5. Utilize Local Welding Shops if you are not equipped to do your own oxy-acetylene cutting.
6. Move Scrap Fast when it is ready. Sell it to a scrap dealer—turn it over to your local salvage committee—or give it to a local charity. But get it in!

*To help you identify metals for efficient classification of your scrap, we will be glad to send you without charge as many copies as you need of the wall chart, "Identifying Metals by Spark Testing." *Ask for Form 4666.* Another useful chart that you can obtain from any Linde office is, "Simple Tests for Identifying Metals by Appearance, Chip Test, and Blowpipe Test." *Ask for Form 2299-D.*

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

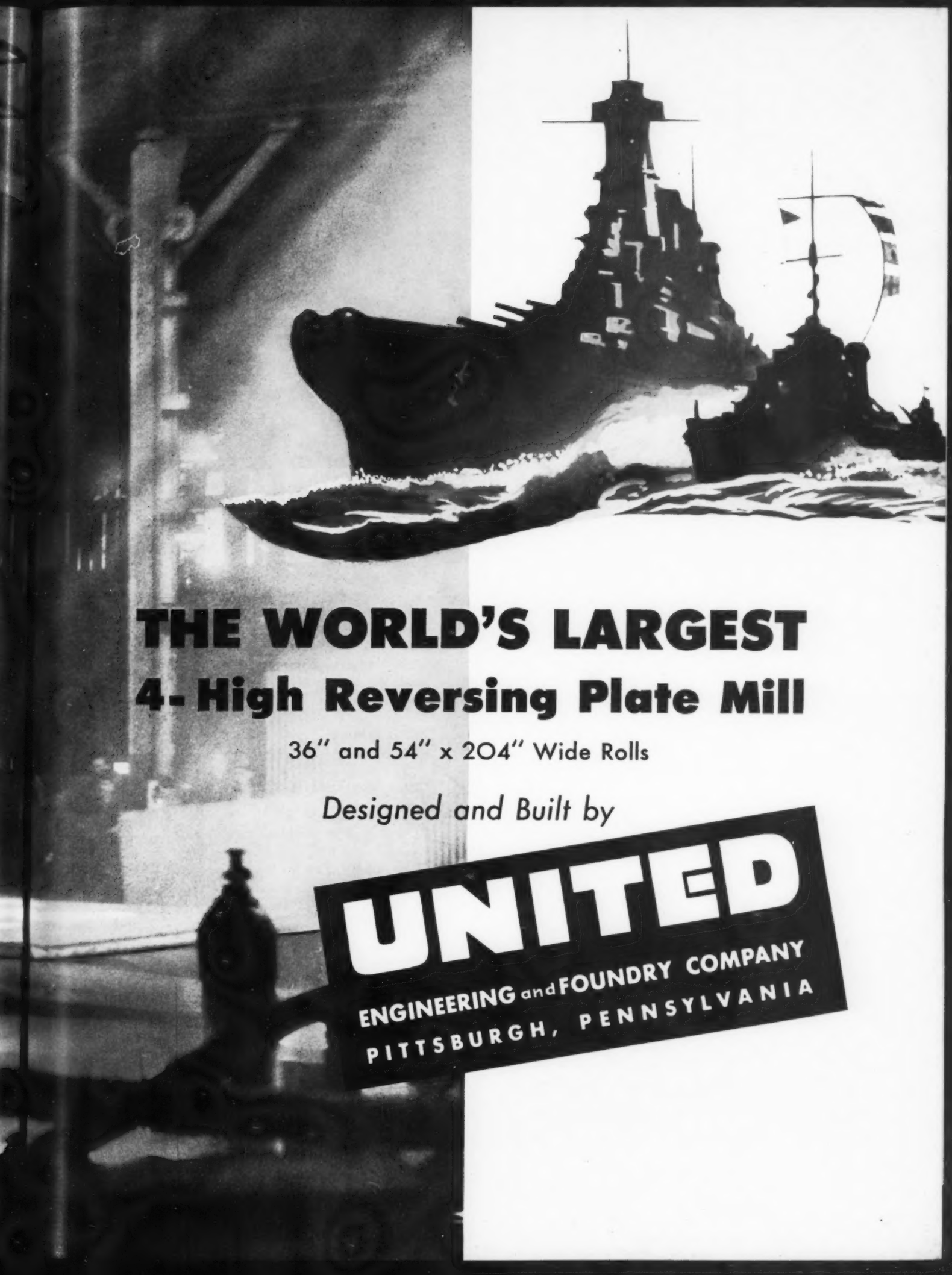
30 E. 42nd St., New York, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks.

UNITED



THE WORLD'S LARGEST
4-High Reversing Plate Mill

36" and 54" x 204" Wide Rolls

Designed and Built by

UNITED

ENGINEERING and FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

OHIO ARMORED WEATHER PROOF CONNECTORS

Save time to make or break connections.

They are operated by hand, (See the Bayonet Joint in Cut.)

No Tools or Tape required.

No danger, live parts covered by insulated Iron Shell.

Two Pole Connectors have Automatic Spring Cover closing live end when not connected.

They also have support Ears for mounting (see cut).

Single Pole Connectors are furnished without Spring Closing Covers or Support Ears.

Cable Ends are No. 4 B & S Extra Flexible Insulated Wire.

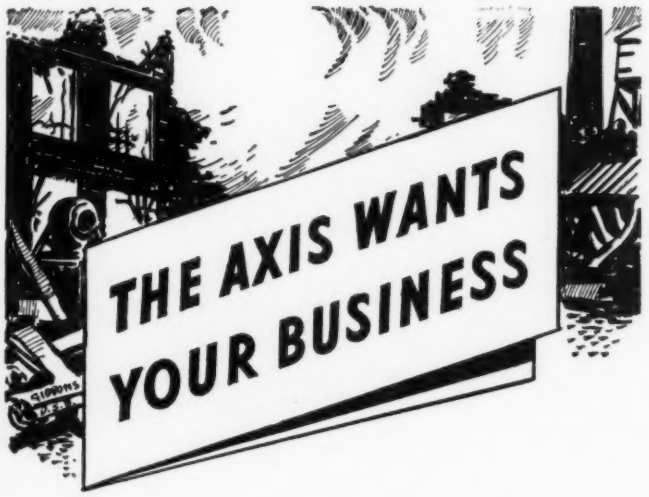
Capacity 150 amperes continuous.

	Weight	Net Price
Single Pole Connectors	5 Lbs.	$12.00 Each
Double Pole Connectors	13½ Lbs.	$25.00 Each
Lower or Plug End Separately		$ 7.50 Each

F. O. B. CLEVELAND

OHIO reliable MAGNETS

The OHIO Electric Mfg. Company
5907 Maurice Avenue
Cleveland · · Ohio



THIS is more than a war of mechanical monsters clashing in the night . . . more than a war of production.

It is a war for markets—*your* markets! The Axis wants your business—wants to destroy it for once and all.

With so much at stake, there is no doubt you will want to do everything you can to meet this Axis threat. Two ways are open: Speed production and BUY BONDS. The only answer to enemy tanks and planes is *more* American tanks and planes—and your regular, month-by-month purchases of Defense Bonds will help supply them. Buy now *and keep buying*.

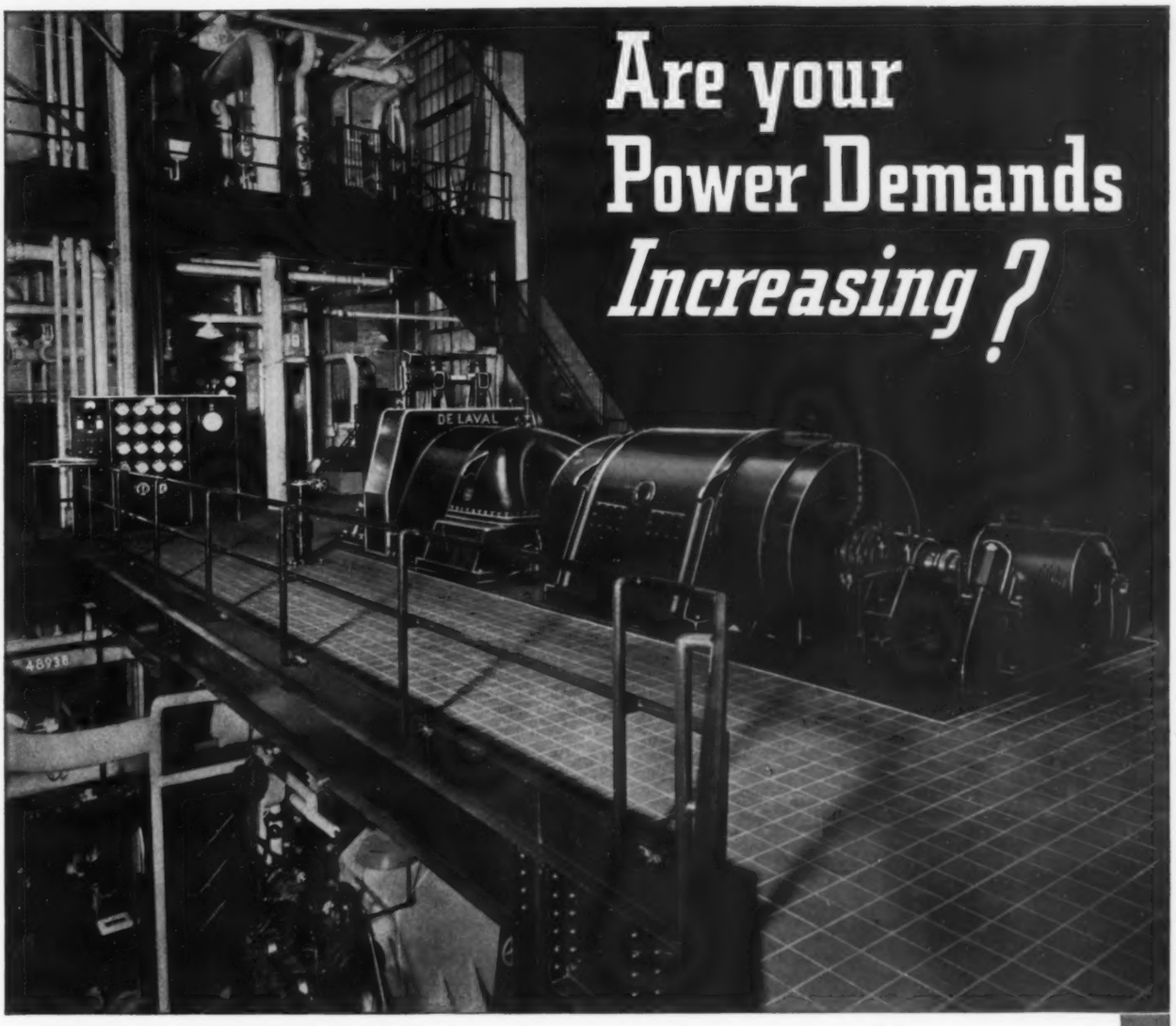
HOW THE PAY-ROLL SAVINGS PLAN HELPS

When you install the Pay-Roll Savings Plan (approved by organized labor), you not only perform a service for your country but for your *employees*. Simple to install, the Plan provides for regular purchases of Defense Bonds through voluntary pay roll allotments.

Write for details *today!* Treasury Department, Section R, 709 Twelfth Street, NW., Washington, D. C.

U. S. SAVINGS

Bonds ⋆ Stamps



Are your Power Demands *Increasing?*

You can produce more power from a given amount of process steam by installing a high pressure boiler and a

DE LAVAL TURBO-ALTERNATOR

arranged for either back pressure or extraction and condensing operation.

The photograph shows such a unit designed to deliver 4,000 kw. (5,000 kw. maximum) from 425 psi. steam at 720° F., exhausting to condenser, with extraction from the sixth, eleventh and sixteenth stages for heating feed water and heating a hospital.

The unit is designed to operate in parallel with outside power and is equipped with an accurate and sensitive governor, which through two stages of hydraulic relay amplification operates the first stage nozzle valves by groups successively, to realize high efficiency at all loads. Synchronization is accomplished by a motorized speed adjustment. A similar De Laval unit rated at 6,000 kw. has since been ordered.

De Laval turbines are of the impulse type, with ample bucket clearances, which, with provisions to equalize expansion, permits quick starting.

All materials have been specially selected to withstand steam at high pressure and temperature. Segregation of condensation in the low pressure stages improves efficiency and reduces erosion of buckets.

Describe your steam and power requirements and ask for Publication T-3523.

DE LAVAL STEAM TURBINE CO. · TRENTON, N. J.

JONES DOOR HOISTS
for handling furnace doors

Two Jones door hoists as installed for opening and closing mill building doors

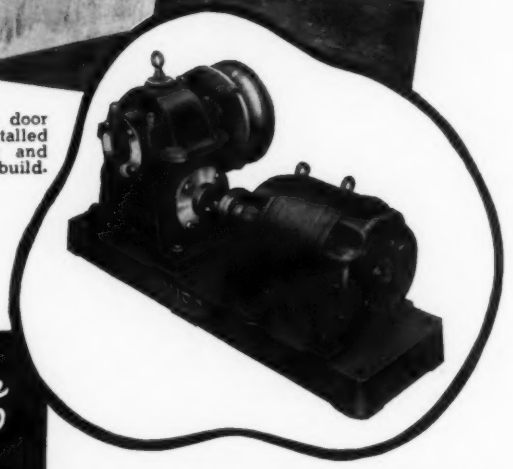
● Here is a simple, compact and sturdy heavy duty worm gear driven door hoist that has been widely used in the steel industry for handling furnace doors. It is also applicable to other services where doors of various types must be opened and closed and where it is desired to avoid the complications of limit switches.

With the Jones door hoist there is not the slightest hazard created by the possibility of over-travel. When the door is opened, if the motor is not stopped, a bronze ring on the winding drum slips and no damage can result . . . When the door is closed, the bronze ring again slips until the motor is stopped.

Thus the Jones door hoist automatically prevents over-winding and eliminates the necessity for expensive limit switches, brakes, or other electrical apparatus designed to prevent over-winding that might be dangerous or damage the equipment. Consequently this drive is simple, economical and fool-proof in its operation.

These door hoists are built by Jones as complete units with motor included if desired, or with base to take standard motor, as supplied by the purchaser.

If you have a door handling problem, our engineering department will be pleased to make a recommendation covering a unit that will handle it.



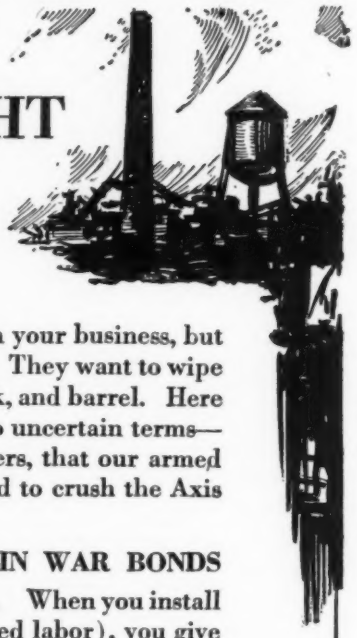
Jones door hoists are built in several ratings and may be installed in almost any convenient arrangement of sheaves and cables. Base will take any standard motor. **NO LIMIT SWITCHES OF ANY KIND REQUIRED WITH THIS UNIT.**

W. A. JONES FOUNDRY & MACHINE CO.
4431 Roosevelt Road, Chicago, Illinois

Jones *Since 1890*

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS • CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES
ANTI-FRICTION PILLOW BLOCKS • PULLEYS • FRICTION CLUTCHES • TRANSMISSION APPLIANCES

TARGET FOR TONIGHT
. . . *Your Business?*



Maybe they won't actually come and drop a *bomb* on your business, but the Axis war lords have their eye on it, just the same. They want to wipe it out as a competitive force—or take it over lock, stock, and barrel. Here is a threat that you can reply to *now*, today, and in no uncertain terms—by buying War Bonds to the very limit of your powers, that our armed forces may have the guns, tanks, and planes they need to crush the Axis *once and for all.*

THE GOAL: 10% OF EVERYONE'S INCOME IN WAR BONDS

Every American wants the chance to help win this war. When you install the Pay-Roll War Savings Plan (approved by organized labor), you give your employees that chance. For details of the plan, which provides for the systematic purchase of War Bonds by voluntary pay-roll allotments, write: Treasury Department, Section S, 709 12th St. NW., Washington, D. C.

Buy War Savings Bonds

This space is a contribution to America's All-Out War Program by

IRON AND STEEL ENGINEER

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ROLL OUT THE STEEL

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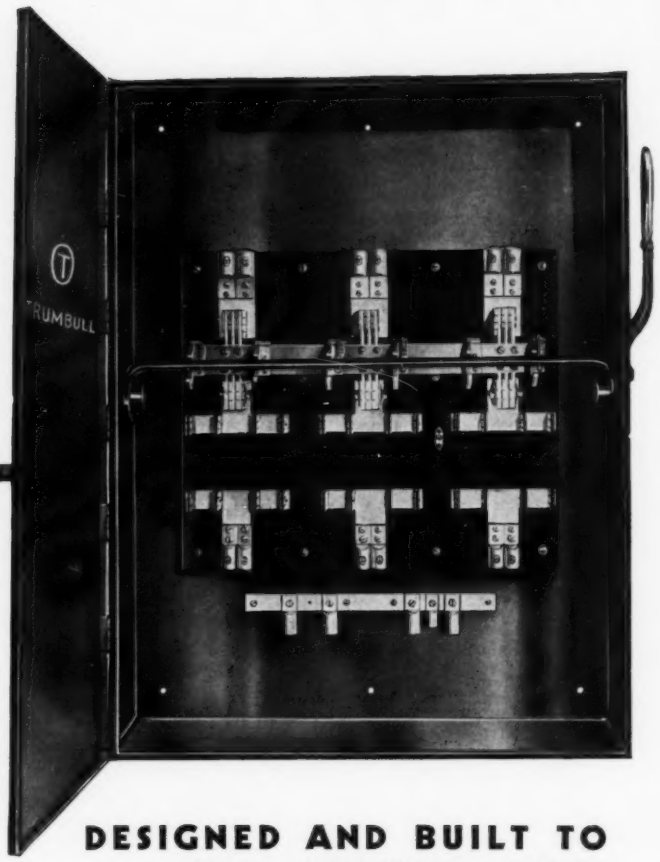
THE STEEL MAN'S SAFETY SWITCH

THE Trumbull nameplate is a familiar sight in steel mills . . . on industrial safety switches that guard thousands of heavily loaded lighting and power circuits. Trumbull Type "A" design has, in fact, long been favored by steel mill electrical engineers, not only because of features that satisfactorily meet the special requirements of mill operation, but also because these switches have the "reserve capacity" that comes with true heavy duty construction.

Trumbull is proud of this acceptance in the Steel Industry . . . proud to be represented on the biggest production job of this war. Our engineering department is always at your service.



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- Quick-make, quick-break feature prevents pitting of contacts, lengthens service life. Interlocking cover. Rated in horsepower for motor disconnect.
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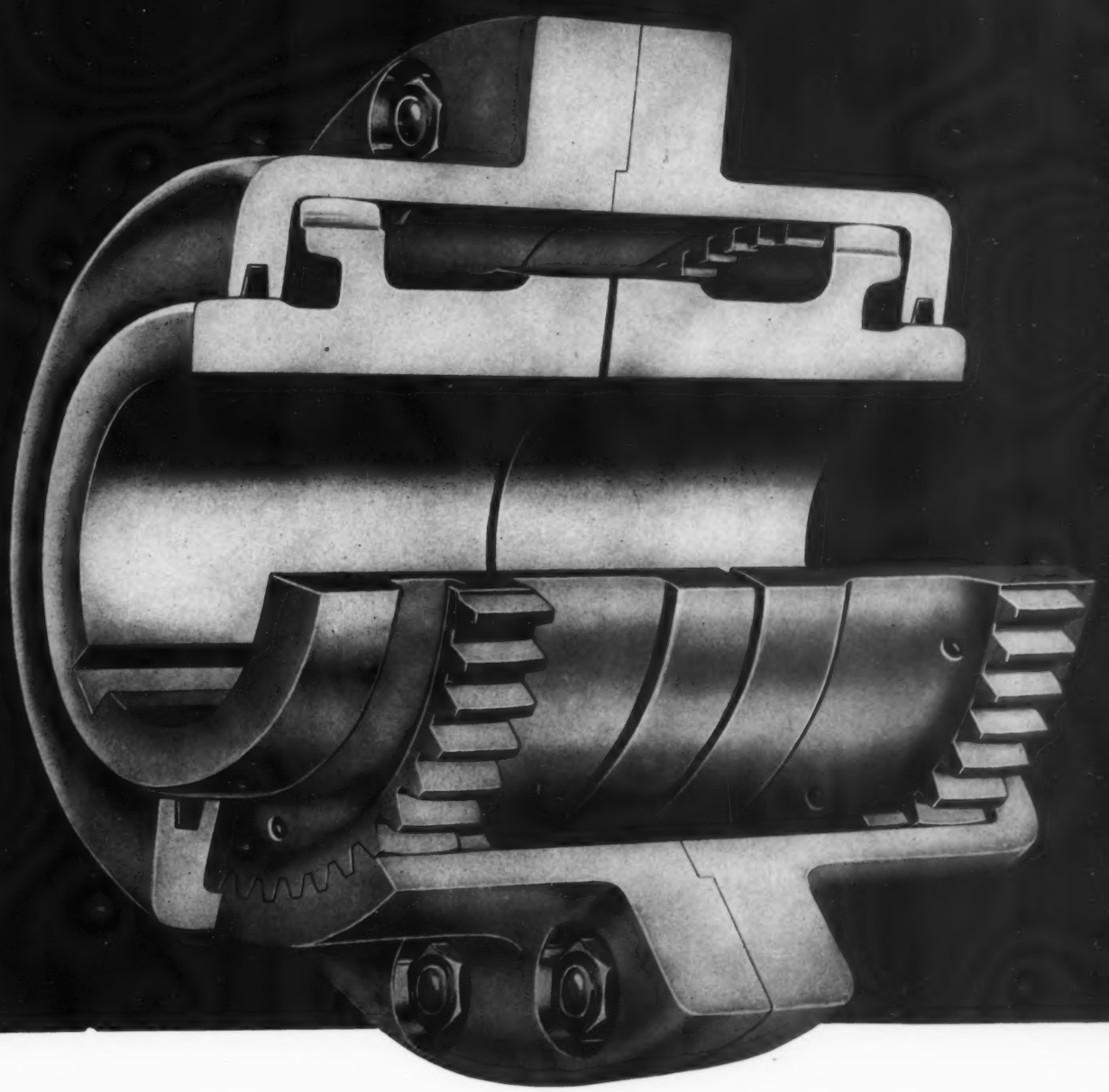

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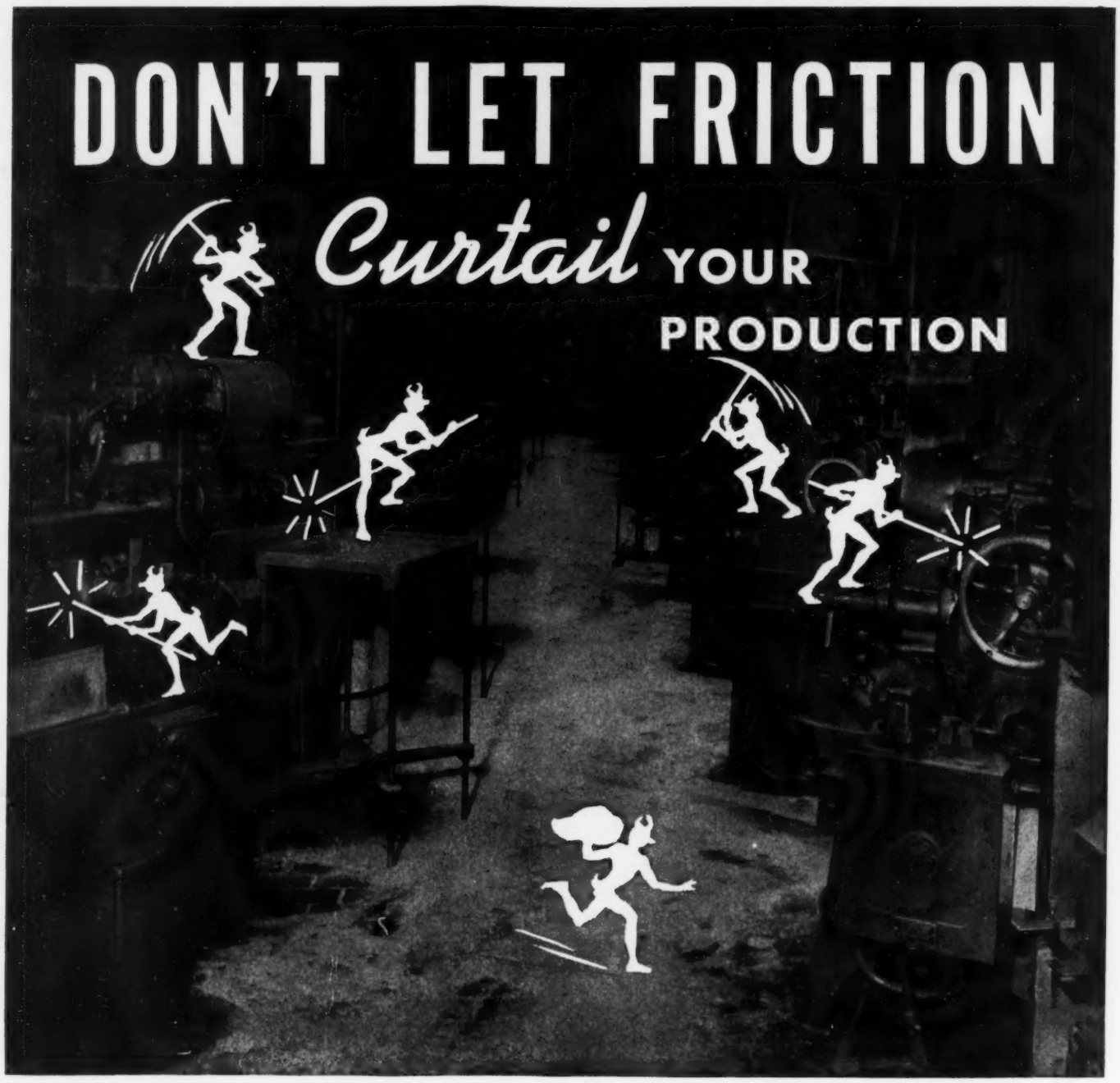
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.



In the high-speed drive for Victory, FRICTION finds its greatest opportunity. Machine operators have rest intervals, but the machines themselves have none. And so, normal inspections and adjustments may be overlooked—lubrication may be neglected—a bearing becomes dry or dirty, and over-heated—FRICTION'S agents get in their deadly work—and A DAMAGED, BURNED-OUT OR RUINED BEARING CRIPPLES A VITAL TOOL.

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PROTECTING ELECTRICAL CIRCUITS ON SHIPS

(Just as they do in industry)

I-T-E Thermal CIRCUIT BREAKERS

There are sixty-three thermal circuit breakers in the marine switchboard illustrated above. They are of three types: twelve 600-ampere frame (right, below); eight 225-ampere frame (left, below); forty-three 100-ampere frame (right).

DO NOT THINK that in building ships at unheard-of speed, American designers and naval architects have lowered their standards for electrical protection. Not in the slightest.

The I-T-E switchboard shown above and the circuit breakers in it are built as exactingly as any equivalent protective apparatus ever made under peacetime conditions.

Thermal circuit breakers are emphasized here particularly because they contain many parts in extremely compact arrangements. The assembly of these breakers is no child's play. Yet with production moving at top speed every I-T-E thermal circuit breaker that goes into service has passed all tests—and they are TESTS.

Whether the intended service for protective equipment is aboard ship or ashore, there can be no compromise with long-established standards of design and workmanship.

Representatives in Principal Cities

I-T-E

AIR SWITCHGEAR

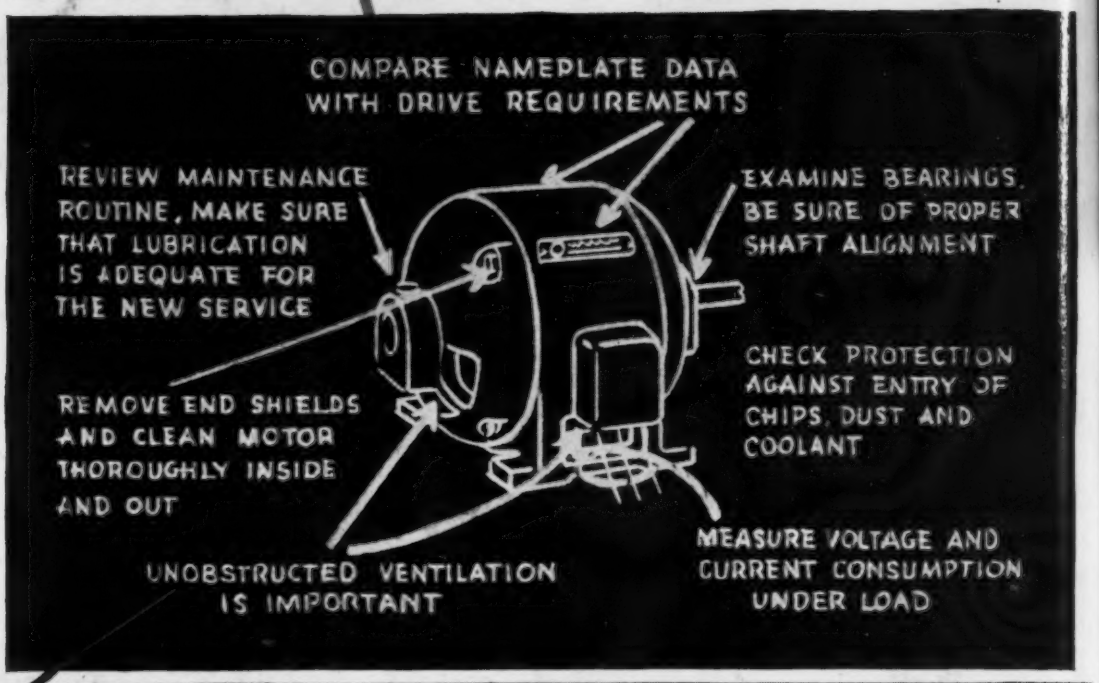
IMMERSED IN AIR — ENCASED IN STEEL

The Army-Navy "E" for Production Excellence

CIRCUIT BREAKER CO., PHILADELPHIA, PA.

MOTOR CARE

IT'S TIME TO BE A CRANK ABOUT


COMPARE NAMEPLATE DATA WITH DRIVE REQUIREMENTS
REVIEW MAINTENANCE ROUTINE, MAKE SURE THAT LUBRICATION IS ADEQUATE FOR THE NEW SERVICE
EXAMINE BEARINGS. BE SURE OF PROPER SHAFT ALIGNMENT
CHECK PROTECTION AGAINST ENTRY OF CHIPS, DUST AND COOLANT
REMOVE END SHIELDS AND CLEAN MOTOR THOROUGHLY INSIDE AND OUT
UNOBSTRUCTED VENTILATION IS IMPORTANT
MEASURE VOLTAGE AND CURRENT CONSUMPTION UNDER LOAD

protect your production with this maintenance plan

Planned motor maintenance, keyed to today's loads and conditions, saves vital hours by forestalling future breakdowns and delay. In replacing hit-or-miss motor servicing with a regular schedule of trouble-*prevention*, you'll find real help in the new G-E publication, "How to Care for Motors."

The check list (right) tells what to do. This book tells how to do it, using well-proved methods that save time and help assure long-lasting motor service.

And, of course, your local G-E Motor Representative is always ready to aid you in putting these suggestions into practice, or in getting the new motors you may need for essential wartime projects.

The Navy "E", for Excellence, has been awarded to 92,780 General Electric employees in six plants manufacturing naval equipment.

1 Make sure that motors are selected to *match the job.* Install motors so they are properly aligned with the driven load and are easily accessible for regular inspection.

See "How to Care for Motors"

2 Keep motors free from dust and dirt. Establish a definite cleaning schedule.

See "How to Care for Motors"

3 Be sure that lubrication is frequent enough to take care of increased production. See that employees are instructed as to proper methods.

See "How to Care for Motors"

4 A general overhauling of hard-worked motors will add years to their life. If your motors haven't had an overhaul in the last year, try to arrange your schedule to permit one.

See "How to Care for Motors"

General Electric, Sec. F750-179
Schenectady, N. Y.

Yes, send me a copy of "How to Care for Motors," GEA-2856A.

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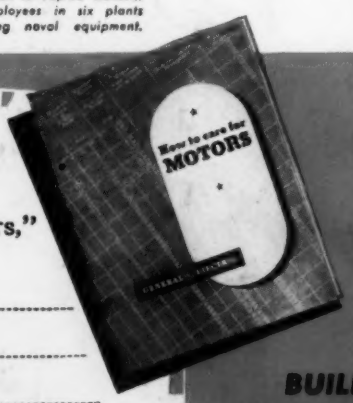

HOW TO CARE FOR MOTORS

Every supervisor and maintenance man will find this book of value . . . it tells what to do to get the most out of motors, old or new. If you're setting up a maintenance program to keep up with today's unprecedented demands, or if you're "switching" motors from one job to another, or equipping machines with new motors, you'll find this booklet of helpful motor facts will save you time. Write for a copy.

BUILDER OF TRI-CLAD MOTORS

GENERAL ELECTRIC